A SYNOPSIS OF HYGIENE

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HYGIENE

(JAMESON AND PARKINSON)

EIGHTH EDITION

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PREFACE TO THE EIGHTH EDITION

ALTHOUGH the last edition of this book appeared as recently as 1942, another edition has become necessary on account of the large amount of new information that has accumulated mainly as a result of the stimulus of war-time conditions.

An effort has been made to see that the size of the book has not been increased. Part of Appendix I on climatology and Appendix II on the vitamin content of various foodstuffs have been omitted. Section II, which deals with the prevention and control of disease, has needed considerable amendment and now includes references to recent work on chemotherapy, venereal diseases, typhus fever, yellow fever, epidemic infective hepatitis and leptospirosis. The notes on various animal parasites have been amended and re-arranged. It may be noted that a summary of the Government's proposals for a National Health Service will be found immediately preceding Section I.

It has not been easy to obtain statistical data and in some cases it has been impossible, for reasons of security. In accordance with present procedure, rates for more recent years have been based on the 1939 population figures.

Perhaps never in the history of medicine has there been a period when more revolutionary changes have taken place than during the present war, and these will have a very marked effect upon future developments. It was originally hoped that it would be possible to omit from this book emergency legislation, but, as this is affecting public health work to such an extent and as some of it is likely to become permanent, much of this temporary war-time legislation has had to be included.

Once again Miss K. M. Shaw has taken a very active part in producing another edition of this book. Indeed, it would not be too much to say that my labours have been halved by the share she has taken in its preparation. My thanks are also due to His Majesty's Stationery Office for permission to reproduce the plans of the Model Health Clinic, to Lt.-Col. E. F. W. Mackenzie for revising the section on water supplies and to Col. L. W. Harrison, who has amended the section on

venereal diseases. I am grateful also to Col. H. J. Bensted and to Dr. H. J. Parrish whose advice and assistance have been most valuable and to members of the staff of the various Government Departments who have always been ready to provide me with necessary data. Dr. G. P. Crowden has again been responsible for the section on personal hygiene and Mr. H. H. Clay has assisted, as in the past, with the portion of the book which deals with domestic sanitary engineering. In addition, I wish to thank other members of the staff of the School and of the Bureau of Hygiene and Tropical Diseases whose help has been so willingly given.

G. S. P.

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ABBREVIATIONS

B.M.A. . . .	British Medical Association.
B.M.J. . . .	*British Medical Journal.*
C.B.C. . . .	County Borough Council.
C.C.	County Council.
C.M.O. . . .	Chief Medical Officer.
D.P.H. . . .	Diploma in Public Health.
D.S.I.R. . . .	Department of Scientific and Industrial Research.
L.A.	Local Authority.
L.C.C. . . .	London County Council.
L.G.A. . . .	Local Government Act.
L.G.B. . . .	Local Government Board.
M. and C.W. . .	Maternity and Child Welfare.
Min. of Ag. and Fish. .	Minister (or Ministry) of Agriculture and Fisheries.
Min. of H. . . .	Minister (or Ministry) of Health.
M.O.H. . . .	Medical Officer of Health.
M.R.C. . . .	Medical Research Council.
P.H.A. . . .	Public Health Act.
R.D.C. . . .	Rural District Council.
S.I.	Sanitary Inspector.
U.D.C. . . .	Urban District Council.
U.S.P.H.S. . . .	United States Public Health Service.
V.D.	Venereal Diseases.

A NATIONAL HEALTH SERVICE

A Government White Paper on this subject (Cmd. 6502) was presented to Parliament in February, 1944, and the following is a summary of the main proposals.

1. *Scope of the new Service.*

(a) A National Health Service will be established. This service will be available to every citizen in England, Scotland and Wales.

(b) There will be nothing to prevent those who prefer to make private arrangements for medical attention from doing so. But, for all who wish to use the service it will provide a complete range of personal health care—general and specialist, at home, in the hospital and elsewhere.

(c) The service will be free, apart from possible charges for certain appliances. (Questions of disability benefits will be dealt with in later proposals on social insurance.)

2. *Structure of the Service.*

(a) *Central.*

(i) Central responsibility to Parliament and the people will lie with the Minister of Health and the Secretary of State for Scotland.

(ii) At the side of the Minister there will be a professional and expert advisory body to be called the Central Health Services Council. The Council will be a statutory body and its function will be to provide professional guidance on technical aspects of the Health Service. There will be a similar body in Scotland.

(b) *Local.*

(i) Local responsibility will be based on the county and county borough councils, which are the major local government authorities now. They will administer the new service partly in their present separate capacities over their present areas, partly—as the needs of the service require—by combined action in joint boards over larger areas.

(ii) Areas suitable for hospital organisation will be designated by the Minister after consultation with local interests.

(iii) The county and county borough councils in each area will combine to form a joint authority to administer

the hospital, consultant and allied services; in the few cases where the area coincides with an existing county area the authority will be the county council of that area.

(iv) At the side of each new joint authority there will be a consultative body—professional and expert—to be called the Local Health Services Council.

(v) Each joint authority will also prepare—in consultation with the Local Health Services Council—and submit for the Minister's approval an "area plan" for securing a comprehensive Health Service of all kinds in its area.

(vi) County and county borough councils combining for these duties of the new joint authority will also severally be responsible for the local clinic and other services in accordance with the area plan. Responsibility for child welfare will be specially assigned in whatever way child education is assigned under the current Education Bill.

3. *Hospital and Consultant Services.*

(a) It will be the duty of the joint authorities themselves to secure a complete hospital and consultant service for their area —including sanatoria, isolation, mental health services, and ambulance and ancillary services in accordance with the approved area plan.

(b) The joint authorities will do this both by direct provision and by contractual arrangements with voluntary hospitals (or with other joint authorities) as the approved area plan may indicate.

(c) The powers of present local authorities in respect of these services and the ownership of their hospitals will pass to the joint authority.

(d) Voluntary hospitals will participate, if willing to do so, as autonomous and contracting agencies; if so, they will observe the approved area plan, and certain national conditions applying to all hospitals in the new service alike; they will perform the services for which they contract under the plan, and receive various service payments from both central and local funds.

(e) Special provision will be made for inspection of the hospital service through centrally selected expert personnel.

(f) Consultant services will be made available to all, at the hospitals, local centres, or clinics, or in the home, as required; they will be based on the hospital service, and arranged by the joint authority, either directly or by contract with voluntary hospitals under the approved area plan.

(g) Measures for improving the distribution of consultants, dealing with methods of appointment and remuneration, and

relating the consultant service to other branches of the new service generally, will be considered after the report of the Goodenough Committee.

4. *General Medical Practice.*

(a) Everyone will be free, under the new Health Service, to choose a doctor—the freedom of choice being limited, as now, only by the number of doctors available and the amount of work which each doctor can properly undertake.

(b) Medical practice in the new service will be a combination of grouped and separate practice.

Grouped practice means practice by a group of doctors working in co-operation.

Separate practice means practice by a doctor working on his own account—broadly similar to practice under the present National Health Insurance scheme, but with important changes.

(c) Grouped practice will be conducted normally, though not exclusively, in specially equipped and publicly provided Health Centres. In England and Wales, the Centres will be provided and maintained by county and county borough councils—in Scotland, by the Secretary of State with power to delegate to a local authority.

(d) General practice in the National Health Service will be in the main organised centrally under the responsible Health Ministers. All the main terms and conditions of the doctor's participation will be centrally settled, and much of the day-to-day administration will be the function of Central Medical Boards—one for England and Wales and one for Scotland—largely professional in composition, and acting under the general direction of the Health Ministers.

(e) The main duties of each Board will be :—

(i) to act as the " employer " of the doctors engaged in the public service. Thus, the Board will be the body with whom every doctor will enter into contract. In the case of practice in Health Centres in England and Wales, however, there will be a three-party contract between the Board, the local authority and the doctor.

(ii) To ensure a proper distribution of doctors throughout the country. For this purpose the Board will have power to prevent the taking over of an existing public practice or the setting up of a new public practice in an area which is already " over-doctored."

(f) It is not proposed that there should be a universal salaried system for doctors in the new service. Doctors engaged in Health Centres will be remunerated by salary or the equivalent ; doctors in separate practice normally by capitation

fee. In some cases—e.g. grouped practice not based on a Health Centre—remuneration by salary or the equivalent could be arranged if the doctors concerned so desired. Rates of remuneration will be discussed with the medical profession.

(g) It is not proposed to prohibit doctors in public practice from engaging also in private practice for any patients who still want this. Where a doctor undertakes private in addition to public practice, the number of patients he is permitted to take under the National Service—and consequently his remuneration—will be adjusted.

(h) Young doctors entering individual practice in the public service for the first time will normally be required to serve for a period as assistants to more experienced practitioners, and the Board will be able to require them to give full time to the service if necessary.

(i) Compensation will be paid to any doctor who loses the value of his practice—e.g. by entering a Health Centre or because he is prohibited from transferring the practice to another doctor on the ground that there are too many doctors in the area.

Superannuation schemes will be provided for doctors in Health Centres and the possibility of providing them in other forms of practice will be discussed with the profession, and the practicability of abolishing the sale and purchase of public practices will be similarly discussed.

(j) Arrangements for the supply of drugs and medical appliances will be considered and discussed with the appropriate bodies.

5. *Clinics and other Services*

(a) It will be the duty of the joint authority to include in its area plan provision for all necessary clinics and other local services (e.g. child welfare, home nursing, health visiting, midwifery and others), and to provide for the co-ordination of these services with the other services in the plan.

(b) County and county borough councils will normally provide most of these local services. The exact allocation of responsibility between the joint authority and the individual county and county borough councils will be finally settled in each case in the approved area plan ; but the principle will be that services belonging to the hospital and consultant sphere will fall to the joint authority while other local and clinic services will fall to the individual councils.

(c) Child welfare duties will always fall to the authority responsible for child education under the new Education Bill.

(d) New forms of service, e.g. for general dentistry and care of the eyes, will be considered with the professional and other

interests concerned. In the case of dentistry the report of the Teviot Committee is awaited.

6. *Organisation in Scotland.*

(a) The scope and objects of the service will be the same in Scotland as in England and Wales, but subject to certain differences due to special circumstances and the geography and existing local government structure in Scotland.

(b) The local organisation in Scotland will differ from that in England and Wales and will be on the following lines :—

(i) Regional Hospitals Advisory Councils will be set up for each of five big regions. The Councils will be advisory to the Secretary of State on the co-ordination of the hospital and consultant services in each region.

(ii) Joint Hospitals Boards will be formed by combination of neighbouring major local authorities (county councils and town councils of large burghs) within the regions to ensure an adequate hospital service in their areas. The Boards will take over all responsibility for the hospital services of the constituent authorities (including services like the tuberculosis dispensaries, which essentially belong to the hospital and consultant field) and will also arrange with voluntary hospitals.

(iii) The joint boards will prepare a scheme for the hospital service in their areas and submit this to the Secretary of State, who will consult the Regional Hospitals Advisory Council before deciding to approve or amend it. The powers of the Secretary of State will be strengthened to enable him to require major local authorities to combine for any purpose proved necessary after local enquiry.

(iv) Education authorities (county councils and town councils of four cities) will retain responsibility for the school health service and clinics, until the medical treatment part of the school service can be absorbed in the wider health service. Existing major health authorities (county councils and town councils of large burghs) will normally retain responsibility for the ordinary local clinic and similar services ; the necessary co-ordination will be secured through their membership of the joint hospital boards and through the Local Medical Services Commitees (below).

(v) Local Medical Services Committees—advisory bodies consisting of professional and local authority representatives—will be set up over the same areas as the Joint Hospitals Boards. The Committees will advise the Secretary of State on local administration of the general practitioner service and will provide liaison between the different branches of the service.

7. *Finance.*

It is estimated that the cost of the new National Health Service will be about £148,000,000 a year compared with about £61,000,000 spent from public funds on the present health services. The cost will be met from both central and local public funds. The arrangements as affecting the various local authorities and the voluntary hospitals are fully considered in the White Paper and more briefly in "A National Health Service—The White Paper Proposals in Brief," also issued in February, 1944.

A SYNOPSIS OF HYGIENE

SECTION I

PUBLIC HEALTH ADMINISTRATION AND THE COLLECTION OF VITAL STATISTICS

DEVELOPMENT OF PUBLIC HEALTH ADMINISTRATION

PUBLIC health administration as we know it to-day began to take shape in England in the nineteenth century, and we owe its beginnings to the first outbreak of cholera in 1831. A consultative Central Board of Health was established to advise as to the measures to be taken to control the disease. This body recommended that local boards of health should everywhere be formed with power to appoint inspectors who should endeavour to remedy obvious sanitary defects such as overcrowding and accumulations of filth. These were temporary arrangements to deal with a national emergency, but already public opinion was eager for reform. In 1832 the Reform Act was passed which brought into being a representative Parliament by disfranchising the smaller boroughs and extending the county vote, and in the same year a Royal Commission was appointed to inquire into the working of the Poor Laws—with Edwin Chadwick as its secretary. The Commission's Report led to the passing of the Poor Law Amendment Act, 1834, which abolished the parish as the unit of poor law government and set up unions of parishes in its place, with local guardians of the poor appointed on an elective basis. A Central Poor Law Board of Commissioners was established, and to this Board both guardians and their officers were made directly responsible. The boards of guardians were the first permanent local authorities charged with communal medical duties. In 1835 the Municipal Corporations Act was passed which defined by schedule the places to be constituted municipal boroughs, made their councillors elective, gave town councils the power to levy a rate, and made the borrowing of money subject to Government approval. In 1833 the first factory inspectors were appointed to assist in the enforcement of the legal requirements regarding the employment of children and young persons in mills and factories. Registration of births, deaths and marriages was introduced in 1836; and in 1848 the first Public

Health Act was passed. This Act provided for a General Board of Health, and gave populous areas the power to establish local boards to deal with matters affecting health, including the appointment of medical officers of health and inspectors of nuisances. This Act was to remain in force for five years. By this time the first medical officers of health had been appointed under powers granted by local Acts—Dr. Duncan in Liverpool in 1847 and Dr. Simon in the City of London in 1848.

The General Board of Health, which was subjected to much hostile criticism on account of the somewhat autocratic manner in which it conducted its business, ceased to exist in 1858. Its medical duties were taken over by the Privy Council, to which body was also transferred Simon, who had been appointed first medical officer to the General Board of Health in 1855. Simon continued in office till after the formation of the Local Government Board in 1871.

The Local Government Board owed its origin to a recommendation of the Royal Sanitary Commission of 1869, and to it were transferred the staffs of the Poor Law Board, the General Register Office, the Local Government Office and the Medical Department of the Privy Council.

The appointment of medical officers of health by all local authorities was made compulsory in 1872. In 1875 the Public Health Act was passed to consolidate all existing public health legislation. This Act divided England and Wales into urban districts and rural districts, and made their elected councils, respectively, urban sanitary authorities and rural sanitary authorities. Urban sanitary authorities consisted of the Town Councils of Boroughs, Improvement Commissioners in local Improvement Act districts and Local Boards in Local Government districts. Rural sanitary authorities were the Boards of Guardians of such areas of unions of parishes as were not within an urban district. The Local Government Act, 1888, brought to an end much of the local management of county affairs exercised by the Justices of the Peace in Quarter Sessions. It established county councils on an elective basis, and instituted a new class of borough, the county borough, in the case of towns having a population of 50,000 or upwards. These county boroughs were expressly exempted from the jurisdiction of the newly appointed county councils, which otherwise were given supervisory powers over the districts within their counties. The Act also empowered the newly created county councils to appoint medical officers of health, and made compulsory the possession of a *registered* diploma in public health (or its equivalent) in the case of a county medical officer of health, and of a medical officer of health of any district or combination of districts with a population of 50,000 or over.

The Local Government Act, 1894, developed the county district system, leaving untouched county councils, county borough councils and municipal borough councils. It established urban district councils in all urban areas and rural district councils in all rural areas, and in rural areas it revised the policy of the Public Health Act, 1875, in that the guardians ceased to be elected as such and the district councillors became the representatives of their areas on the boards of guardians.

Education had meantime come to be regarded as one of the great public services. In 1870 elective school boards were established for the local control of education, and between that year and 1891 legislation was passed making elementary education compulsory and free for every child in the country. In 1899 education ceased to be administered by the Privy Council and the Board of Education was brought into being. In 1902 school boards were done away with and the local control of education was handed over to the councils of counties, county boroughs and the larger municipal boroughs and urban districts. It was in this year too that a Central Midwives Board under the Privy Council was established and the central and local control of midwives introduced.

The next seventeen years saw the establishment of the school medical, maternity and child welfare, tuberculosis and venereal disease services and National Health Insurance. The administration of certain of these services was shared between county councils and district councils and the divided control resulted in a certain amount of confusion. At the same time boards of guardians were maintaining large institutions, many of which were really well-equipped modern hospitals, and were concerned with the care of young children, mentally defective persons and sick people on medical out-relief. They were also responsible for the registration of births, deaths and marriages and for the administration of the Vaccination Acts. It was felt, however, that attempts at co-ordination should be made first of all at headquarters and to effect this the **Ministry of Health Act** was passed in 1919. This Act did away with the Local Government Board and secured the appointment of a Minister of Health whose duty it is to prepare, carry out and co-ordinate measures conducive to the health of the people. To him were transferred :—

1. All the powers and duties of the Local Government Board.
2. All the powers and duties of the National Health Insurance Commissioners.
3. All the powers of the Board of Education regarding the health of expectant mothers and nursing mothers, and of children under five years of age not attending a recognised school.

4. All the powers and duties of the Board of Education with respect to the medical inspection and treatment of children and young persons attending school. (Not yet transferred, but the chief M.O. of the Ministry is also chief M.O. of the Board.)

5. All the powers of the Privy Council under the Midwives Act.

6. Such powers of supervising Part I. of the Children Act, 1908 (which related to infant life protection), as were formerly exercised by the Secretary of State.

By Order in Council His Majesty might transfer to the Minister :—

(*a*) The powers and duties of the Minister of Pensions regarding the health of disabled officers and men after they have left the Service.

(*b*) The powers and duties of the Secretary of State under the Lunacy and Mental Deficiency Acts. (Transferred by Order, 17th May, 1920.)

(*c*) Any other powers and duties which relate to matters affecting the health of the people.

The Act further made provision for the establishment of Consultative Councils in England and Wales. These councils are to advise and assist the Minister, and must consist of persons having practical experience of the matters referred to them. Women are to be included as members.

Other central agencies concerned directly or indirectly with health matters are :—

(*a*) Board of Education. As already indicated the medical work of the Board of Education is now done under the authority of the Minister of Health, and opportunity is afforded for consultation between officers of the two departments.

(*b*) Ministry of Pensions dealing with (1) medical assessments or "boarding," (2) medical treatment, (3) finance.

(*c*) Home Office dealing with industrial health and the welfare of workers in factories. This work is at present under the control of the Ministry of Labour and National Service.

(*d*) Medical Research Council—a Committee of the Privy Council dealing with research. Being under the Privy Council, it can extend its activities, *e.g.* to Scotland—beyond the area in which the Ministry of Health operates.

(*e*) Ministry of Agriculture and Fisheries which has extensive duties in relation to the prevention of spread of tuberculosis in cattle, foot and mouth disease, anthrax, rabies.

(*f*) Board of Trade—concerned with the health of the Mercantile Marine.

(*g*) General Medical Council—under the Privy Council.

(*h*) Admiralty, War Office and Air Ministry are responsible for the health of the forces of the Crown.

(*i*) Board of Control—the central authority under the Lunacy Acts, the Mental Deficiency Acts and the Mental Treatment

Act. This Board is subject to the direction of the Minister of Health, who must also sanction applications by local authorities for the borrowing of money in respect of proposals under these Acts.

(*j*) Central Midwives Board—under the supervision of the Minister of Health—is the body concerned with the education, registration and general control of midwives.

It is obvious that complete unification of central control in relation to public health has not yet been obtained but a considerable advance has been made. Local Government is still far from satisfactory in that many of the areas forming units of local government are too small, insufficiently populous or too poor to maintain efficient public health personnel and equipment. There is, however, every indication that, following the present emergency arrangements for the co-ordination of hospital work on a more regionalised basis and for a general scheme for public health laboratory services, and as a result of the Government's decision to establish a comprehensive national health service, still further adjustments in the present system will be made. The control of local authorities by the central authority is mainly financial in character: (*a*) local authorities may not borrow money without the sanction of the Minister of Health, and such sanction will be given only upon certain conditions; (*b*) annual block Exchequer grants are paid to local authorities. These were formerly annual percentage grants on approved net expenditure. The only percentage grants now remaining are those paid in respect of the school medical service and of port health work.

The Local Government Act, 1929, altered completely the system of local government in this country. It came into operation on the 1st April, 1930, and transferred the functions of boards of guardians to the councils of counties and of county boroughs. The public health services transferred were, in the main, the registration of births, deaths and marriages, vaccination, poor law hospitals, medical out-relief, duties in respect of foster children, and the care of the mentally unsound. The aim of this transfer was to prevent much of the overlapping of duties that had occurred in the past.

Every county and county borough council must appoint a public assistance committee for the management of most of these transferred functions. On this committee may be included persons who are not members of the council, but these persons must not exceed one-third of the total membership of the committee and among them must be some women. Each county must be divided into areas, and for each area a sub-committee of the public assistance committee, known as the guardians committee of the area, must be appointed. The guardians committee must include persons not members of the

county council (women as well as men), but such persons must not exceed one-third of the whole number of members of the committee. The guardians committee deal with all applications for relief and may undertake the management of any poor law institutions within the area.

Where in the past boards of guardians granted such services as maintenance and treatment of persons in hospitals and other places, the education of children, etc., by way of poor relief, the councils of counties and county boroughs have been instructed to provide such assistance where possible by virtue of any of the Public Health Acts and the Acts relating to mental deficiency, blind persons and education.

(See p. 197 regarding "declarations" and "appropriation" of institutions for public health purposes.)

The Act required every county council (1) to report to the Minister any alterations deemed desirable in the districts within the county, (2) to arrange by combination of districts or otherwise for securing that every M.O.H. subsequently appointed should be debarred from private practice, and (3) to prepare a scheme for the provision of adequate isolation hospital accommodation for the county. County councils were also authorised to contribute towards the expenditure incurred by district councils on sewers, sewage disposal works and water supplies. District councils were permitted, by agreement, to hand over any of their public health functions to county councils and the Minister was empowered, in the case of a defaulting district council, to order the transfer to the county council of any public health function in respect of which default had been made. These matters have been re-enacted in the L.G.A., 1933 (Sections 111, 112 and 146, see pp. 8 and 10), and in the P.H.A., 1936 (Sections 185, 307 and 320, see pp. 526, 554).

Finally, the Act did away with the system of percentage Exchequer grants in its application to the health services. These grants were paid on condition that local ratepayers paid, normally, an equivalent sum, and involved a minute and continuous central control of the detail of affairs which was properly a matter of local concern. For this system has been substituted a consolidated or block grant. The amount of grant paid to a county or county borough council is based, *inter alia*, on the rateable value, the proportion of the population under five years of age, the volume of unemployment and, in counties, the road mileage. In order to give the Minister control over local services, he has been authorised to hold inquiries into local administration and to withhold grant if the authority fail to achieve or maintain a reasonable standard of efficiency or progress or are guilty of gross extravagance. (*Bull. Hyg.*, September, 1932, pp. 537–44, Picken.)

The Poor Law Act of 1927 consolidated more than a hundred statutes and the Poor Law Act, 1930, consolidated this Act with certain sections of the Local Government Act, 1929, which dealt with the administration of the poor law. The Public Assistance Order, 1930, made no change in the law but contains all the existing Poor Law Regulations which have been issued over a period of years and are often difficult to obtain as separate documents.

The Local Government Act, 1933, and the Public Health Act, 1936, are two great consolidating Acts, the first dealing with the enactments relating to authorities for local government and the second with certain enactments relating to public health. Neither Act applies to London. The Public Health Act, 1936, contains provisions regarding sanitation and buildings; nuisances and offensive trades; water supply; prevention, notification and treatment of disease; hospitals and nursing homes; notification of births; maternity and child welfare; baths and wash-houses, common lodging houses and canal boats.

Local Health Authorities in England and Wales are: *County boroughs.* The councils of county boroughs are local authorities for all purposes. They administer all legislation relating to health and public assistance and are responsible only to such central authorities as the Ministry of Health and the Board of Education.

Administrative counties. These are, in the main, the geographical counties, and their councils are appeal and supervisory authorities so far as the municipal boroughs, urban districts and rural districts within their counties are concerned. They have no jurisdiction within county boroughs. They administer directly public assistance, tuberculosis and venereal disease schemes, the Midwives Acts, the Rivers Pollution Prevention Acts, the Mental Treatment Act, the Nurses Act, the Rats and Mice (Destruction) Act, etc. They are also local control authorities under the Mental Deficiency Act, 1913, and the local authorities for higher education. In such parts of the county as are not large enough to undertake the work they are also responsible for elementary education, maternity and child welfare, and the administration of the Food and Drugs Act. County councils are also local authorities for certain purposes under the P.H.A., 1936, and it should be noted that under this Act (Section 320) county councils may have transferred to them any of the public health functions of a district council. They have now much greater power than formerly to co-ordinate local district administration.

Municipal boroughs, urban districts and rural districts. Their councils are local authorities under the Public Health Acts. The first two may be authorities for maternity and child welfare and for elementary education, while the larger borough and

urban district councils administer the Food and Drugs Act. A few rural district councils undertake maternity and child welfare work. Rural district councils have rather less administrative power than have urban district councils, but may have urban powers conferred upon them by the Minister of Health. An urban district may petition the King (through the Privy Council) for a charter of incorporation with a view to becoming a municipal borough. A municipal borough with a population of over 75,000 may by private bill seek to secure the status of a county borough.

The *Parish council* and the *Parish meeting* are the smallest units of local government and have practically no public health functions.

In England and Wales there are at present (1943) 61 administrative counties, 83 county boroughs, 881 urban districts, 309 municipal boroughs (included in the 881 urban districts), 475 rural districts and 28 metropolitan boroughs in addition to the County and City of London.

Local authorities may act jointly in the exercise of their functions through a joint board constituted by order of the Minister under the P.H.A., 1936, Sections 6 and 8. Any expenses incurred by such joint bodies, unless the order constituting them otherwise determines, are defrayed out of a common fund contributed by the constituent districts in proportion to their rateable values. The joint body issues a precept to each local authority stating the sums to be contributed and requiring them to be paid within a specified time. Joint boards may also borrow money for the carrying out of their duties. Joint committees may be established by local authorities under the L.G.A., 1933, Section 91, without an order of the Minister, but such committees cannot issue a precept for a rate or borrow money.

The L.G.A., 1929, required every county council to confer with representatives of the district councils within the county and to send to the Minister a report indicating any changes considered desirable as regards alteration of boundaries of districts, union of districts, conversion of rural into urban districts, etc. The Minister was empowered to make an order effecting such changes as appeared to him to be expedient. The L.G.A., 1933, Section 146, permits such reviews to be repeated at intervals of not less than ten years and authorises the Minister to require a county council to make a review within a specified time.

Sources of powers of local authorities

Local authorities derive their powers from Public General Acts, and subordinate legislation made under these Acts, and from Local Acts.

Public General Acts alter the general law. As a rule they enable local authorities and the Ministers concerned with the services in question to make provision for the detailed operation of the services. This provision is made usually by means of subordinate legislation, and the action taken by the Ministers may or may not require the special approval of Parliament on each occasion.

Subordinate legislation consists of—

(*a*) Regulations and orders made for purposes authorised by the Acts.

(*b*) Provisional Orders, which require to be submitted to Parliament for legislative confirmation, made for purposes specifically authorised.

(*c*) Bylaws made by local authorities and confirmed or allowed by Ministers.

Local Acts alter the laws relating to some particular locality, or confer rights on, or relieve from liability, some particular person or body of persons. Bills for these purposes are introduced into Parliament by local authorities. Before a private bill is proceeded with, steps must be taken to give local publicity to the proposal and to ensure that it is duly considered and approved by the council. A town council or an urban district council (but not a county council) must obtain the consent of the electors to the proposal at a town's meeting and may be obliged to take a poll. " It is by Local Acts that the first experimental improvements have as a rule been made, and it is from Local Acts that model clauses have been drawn and brought by Parliament into general use."

Adoptive Acts do not come into operation in a district till adopted by the local authority. The procedure to be followed in adoption is laid down in each Act.

Bylaws are laws made by some authority lower than Parliament, *e.g.*, a local authority, in regard to some matter specially referred to the authority and not provided for in the law of the land. The initiative for making bylaws rests in general with the local authorities ; in only a few cases has the Minister power to require local authorities to make bylaws. The Minister's function is generally limited to confirming or refusing to confirm the bylaws submitted. In two instances (bylaws as to buildings and new streets) he has power to revoke a bylaw. Normally bylaws once confirmed continue in force indefinitely unless they lapse for special reasons, for example, as a result of the reviews of local government areas ; but under the Public Health Act, 1936, building bylaws, bylaws for the prevention of waste, etc., of water, and bylaws dealing with fish frying and offensive trades have a limited life in order to prevent their remaining in force when obsolete.

A bylaw, to be enforceable at law, must satisfy four essential

conditions. It must be (1) *intra vires*, (2) certain in its requirements so that persons who have to comply with it may know definitely the action which must be followed or avoided, (3) reasonable, and (4) in harmony with the laws of the country and with the general provisions of the enactment under which it is made. It is important that bylaws should be so framed as to provide a code of minimum requirements, compliance with which can be reasonably enforced by the infliction of a penalty, not of practices which are merely desirable.

Bylaws may be made regarding (among other matters)—

1. Scavenging.
2. Prevention of nuisances from snow, filth, etc., and the keeping of animals so as to be prejudicial to health.
3. Common lodging houses.
4. Buildings.
5. Markets.
6. Slaughter-houses.
7. Swimming baths.
8. Mortuaries and post-mortem rooms.
9. Offensive trades.
10. Tents, vans and sheds.
11. Nursing homes.
12. Smoke abatement.

Sets of model bylaws have been issued by the Min. of Health as a guide to local authorities.

Regulations may also be made by local authorities regarding certain matters, but do not require confirmation by the Min. of Health, with the exception of those made under Sect. 12, Housing Act, 1936, regarding underground sleeping places.

Committees of local authorities. Most of a local authority's business is dealt with first of all in committee. The committees which a county borough is required by statute to appoint and which are concerned with health work are the public assistance committee, maternity and child welfare committee, education committee, committee for the care of the mentally defective, visiting committee under the Lunacy Act, 1890, and diseases of animals committee. Every local authority, in fact, appoints a public health committee, though not required to do so by statute.

The medical officer of health and the sanitary inspector

The conditions of appointment of these officers are laid down in the **Local Government Act, 1933,** Sects. 103 and 106–113. Every county council must appoint one or more fit persons to be county medical officer or officers of health, and such M.O.H. must be a duly qualified medical practitioner who holds a *registered* diploma in public health or its equivalent. He

must not be appointed for a limited time, and may not be dismissed without the consent of the Minister. He must not engage in private practice or hold any other public appointment without the consent of the Minister. He has the same powers of entry on premises as are conferred on a M.O.H. of a county district.

Every borough, urban and rural district council must appoint a M.O.H., and one or more sanitary inspectors, and a vacancy in one or other of these offices must be filled within six months. The Minister may make regulations (see below) prescribing the qualifications and duties of these officers and, in the case of county district officers half of whose salary is paid by the county council to the district council, prescribing the mode of appointment and terms as to salary and tenure of office. No M.O.H. may be appointed to a borough, urban or rural district having a population of 50,000 or more unless he holds a *registered* D.P.H. or its equivalent. Whole-time medical officers of health and senior sanitary inspectors of boroughs and county districts must not be appointed for a limited time only, and may not be dismissed except with the consent of the Minister. County councils are required, after consultation with the district councils, to formulate arrangements for securing, whether by combination of districts or otherwise, that every M.O.H. subsequently appointed to a county district shall be debarred from private practice. The Minister is authorised to make an order uniting districts for the purpose of appointing a M.O.H., provided that no borough or urban district with a population of 20,000 or more, and no borough having a separate Court of Quarter Sessions, may be included in such union without the consent of its council. The M.O.H. of a county district must give the county M.O.H. any information reasonably required. (The necessary authority for the payment by county councils to district councils of half the salary of medical officers of health and sanitary inspectors is contained in the L.G.A., 1933, Sect. 109.)

Under the Public Health Act, 1936, First Schedule, the Minister may make regulations prescribing the qualifications, duties, mode of appointment, and terms as to salary and tenure of office, of port medical officers and sanitary inspectors. Compliance with such regulations is obligatory on every port health authority, and a county council or county borough council must pay annually to a port health district within their area a sum equal to half of the salary of these officers. The appointment of a port medical officer or senior sanitary inspector must not be for a limited period only and these officers may be dismissed by the port health authority only with the consent of the Minister, or by the Minister.

The Local Government Superannuation Act, 1937, requires

provision to be made for the superannuation of all whole-time officers in the employment of local authorities.

Sanitary Officers (Outside London) Regulations, 1935 (made under L.G.A., 1933, Sects. 103 and 108), and Housing Act, 1936, Sect. 67. *County medical officers of health* must visit the several county districts in their counties and advise their county councils on all matters affecting the public health. They must perform all duties imposed on them by legislation, and each must prepare an annual report as soon as practicable after 31st December in each year.

Medical officers of health of districts may not be appointed unless they hold a *registered* D.P.H. or its equivalent. Included in their duties is an obligation weekly to inform the Minister (and in the case of a county district, the county M.O.H. as well) of the number of cases of infectious disease notified during the preceding week, and to report at once to the same authorities any case of plague, cholera or smallpox, or any serious outbreak of disease. As soon as practicable after the 31st December each year an annual report must be prepared and copies of this and of any special reports must be sent to the Minister and to the county M.O.H. In addition, a report must be sent annually to the Minister relating to overcrowding under the Housing Act, 1936 (see p. 631).

In the case of medical officers of health of districts half of whose salary is paid to the district council by the county council: (1) Appointment is subject to the approval of the Minister.

(2) All vacancies must be reported to the Minister and the conditions of appointment approved by him. The vacancy must be advertised at least fourteen days before the appointment is to be considered by the authority, and the amount of salary and other allowances must be stated.

(3) A medical officer not restricted from private practice shall be appointed for a specified time ending on the 31st March next following the date of his appointment, and his appointment may be determined at any time without notice by the Minister, or by the local authority with the consent of the Minister, but not otherwise. (If it is intended that such officer should be continued in office after 31st March, the approval of the Minister must be obtained.)

(4) A L.A. may suspend a M.O.H., but must report the fact to the Minister, who may determine the suspension.

(5) A M.O.H. must agree to give at least one month's notice before resigning.

(6) A L.A. must pay the M.O.H. such salary as may be approved by the Minister, and the terms of the engagement of the M.O.H. may not be varied without the consent of the Minister.

Sanitary inspectors (half of whose salary is paid by the county council to the district council) may not be appointed unless holding :—

(*a*) A certificate of the Royal Sanitary Institute and Sanitary Inspectors Examination Joint Board ; or
(*b*) a certificate of the late Sanitary Inspectors Examination Board ; or
(*c*) a certificate of the Royal Sanitary Institute issued before 1st January, 1926.

If a L.A. employ a qualified veterinary surgeon for meat inspection they may, with the approval of the Minister, appoint him as a sanitary inspector for such purpose only, although he does not hold any of the above certificates.

The method of appointment of sanitary inspectors is subject to the same sort of conditions as in the case of medical officers of health, and the senior sanitary inspector is given similar security of tenure. A sanitary inspector appointed to give part-time service must abstain in his private business from any work arising out of or in any way connected with his duties as sanitary inspector. The S.I. works generally under the direction of the M.O.H. His work is concerned mainly with the inspection of the district and with the detection of nuisances. House inspection and food inspection form a large part of his duties. At the end of each year he must furnish the M.O.H. with a tabular statement showing : (*a*) the number and nature of inspections made by him during the year ; (*b*) the number of notices served during the year, distinguishing statutory from informal notices ; (*c*) the result of the service of such notices. If so directed by the local authority, he must supervise the scavenging of his district and carry out specified duties under the Rats and Mice (Destruction) Act, 1919, the Housing Consolidated Regulations, 1925 and 1932, the Housing Act, 1936, the Shops Act, 1934, and the Food and Drugs Act, 1938.

General. The Minister may dispense with any of these requirements if he so desires.

Annual report of the medical officer of health. Special survey reports may be called for from time to time by the Minister. In the annual reports the following information is usually provided :—

(*a*) Statistics and social conditions of the area. (*b*) General provision of health services. (*c*) Sanitary circumstances of the area. (*d*) Housing. (*e*) Inspection and supervision of food. (*f*) Prevalence of, and control over, infectious and other diseases. Every district M.O.H. must report specifically in his annual report on the administration of Parts I. and VIII. of the Factories Act, 1937. Copies of the Report must be sent

to the Ministry of Health, the Home Office and, if the council are a Local Supervising Authority, to the Central Midwives Board.

Under the *Local Government (Qualifications of Medical Officers and Health Visitors) Regulations*, 1930 *and* 1933, made under the Public Health Act, 1936, Sects. 180 and 204, the following requirements regarding appointments are laid down :—

Tuberculosis officer or medical superintendent. (1) Must have been qualified at least three years ; (2) must have spent not less than eighteen months in general clinical work, including at least six months as resident officer in charge of general medical or surgical beds ; (3) must have received at least six months' special training in the diagnosis and treatment of tuberculosis.

Venereal disease pathologist. (1) Must have been qualified at least three years ; (2) must be certified by a pathologist of an approved laboratory (*a*) as having within the preceding two years personally carried out not less than 500 serum tests for syphilis by a method approved by the Minister, and as being competent to perform such tests ; and (*b*) as having during the same period personally examined microscopically not less than 300 specimens from suspected lesions, and as being competent to conduct such examinations.

Venereal disease officer. (1) Must have been qualified at least three years ; (2) must be certified by a venereal disease officer of a treatment centre, at which not less than 500 patients attended for the first time during the twelve months preceding the issue of the certificate, that he has received not less than 130 hours' instruction at the centre during a period of at least three months.

Senior maternity and child welfare medical officer. (1) Must have been qualified at least three years ; (2) must have had special experience in midwifery and child welfare work ; (3) must have been employed by a local maternity and child welfare authority.

Medical officer of an ante-natal clinic. (1) Must have been qualified at least three years ; (2) must have had special post-graduate experience of practical midwifery and ante-natal work.

Health visitor. (1) Must be in possession of the Health Visitor's Certificate of the Royal Sanitary Institute approved by the Minister, or a specially endorsed certificate of the Royal Sanitary Association of Scotland.

Tuberculosis visitor. Must hold the health visitor's qualification or must be a fully trained nurse who has had at least three months' special experience at a sanatorium or tuberculosis hospital or tuberculosis dispensary.

General. The Minister may dispense with any of the requirements of these regulations if it appears desirable to him so to do.

Training of public health officers

(*a*) Medical officers of health and, usually, assistant medical officers of health must hold a Diploma in Public Health or equivalent qualification. This diploma is controlled by rules of the General Medical Council (see p. 696).

(*b*) Sanitary inspectors must hold the Certificate of the Royal Sanitary Institute and Sanitary Inspectors Examination Joint Board. Before admission to this examination candidates

must produce evidence of having attained a proper standard of general education and must have—

1. Attended for six months a part-time course of lectures and demonstrations given at an approved institution.
2. Undergone practical training in the duties of a sanitary inspector for a period of one year, some reduction in time being made in the case of men who have had at least three years' practical experience in one or other of the building crafts.

It is advisable for inspectors to obtain in addition the Certificate of Inspector of Meat and other Foods granted by the Royal Sanitary Institute.

(*c*) Health visitors must pass the examination for the Health Visitor's Certificate of the Royal Sanitary Institute. Candidates for this examination must be either—

1. Nurses who have undergone a three years' course of training at a recognised general or children's hospital, who have obtained Part I. of the Certificate of the Central Midwives Board, and who have attended an approved whole-time course in public health work lasting for at least six months, or
2. Women, not being trained nurses, who have undergone an approved course of training in public health work for two years, together with six months' training in hospital, and who have obtained Part I. of the Certificate of the Central Midwives Board.

(*d*) Midwives must hold the Certificate of the Central Midwives Board. The training must be provided in institutions approved by the Board and must extend in the case of a State registered nurse over twelve months and in the case of other women two years. Part I. of the training lasts six months for the former and eighteen months for the latter. In the case of trained nurses it includes attendance at a course of at least forty lectures, conduct of ante-natal examinations in not less than fifty pregnant women, witnessing ten labours, personal delivery of not less than ten women in the institution, the nursing of not less than twenty lying-in women, attendance at clinical demonstrations on venereal disease and instruction in the prevention and treatment of ophthalmia neonatorum. Part II. is the same for all pupil midwives and extends over not less than six months. It includes ante-natal care of at least twenty pregnant women, attendance on twenty women in labour of whom at least ten must be attended in their own homes, nursing of at least twenty lying-in women and their children of whom at least ten must be attended in their own homes, attendance at a maternity and child welfare centre, and some instruction in social welfare work. An examination follows each part of the course. The Minister makes grants to

approved institutions in respect of each pupil who completes the first or both parts of the course. (Ministry of Health Memorandum, 211 M.C.W., April, 1938.)

Under the Midwives (Qualifications of Supervisors) Regulations, 1937, a local supervising authority may appoint medical or non-medical supervisors. In the former case the person appointed must have been qualified at least three years, must hold a registered D.P.H., must have held an appointment as resident medical officer in a maternity department for not less than six months and must, within two years of his appointment, have had not less than one year's continuous experience in some branch of obstetric work. A non-medical supervisor must be a registered nurse and certified midwife who must have had at least three years' active practice as a midwife. She must have been in such practice for at least one year within a period of two years prior to her appointment, and she must have had at least one year's experience of attending lying-in women in their own homes.

(The reader desirous of becoming acquainted with the growth of public health legislation and administration is advised to consult "English Sanitary Institutions," Sir John Simon, Cassell & Company, 1890; "The Ministry of Health," Sir Arthur Newsholme, G. P. Putnam's Sons Ltd., 1925; "An Outline of the Practice of Preventive Medicine," Sir George Newman, H.M. Stationery Office, 1926; "A Century of Public Health in Britain," Harley Williams, A. & C. Black Ltd., 1932; "The Building of a Nation's Health," Sir George Newman, Macmillan & Co. Ltd., 1939; "The Reform of the Public Health Services," Sir Arthur S. MacNalty, Oxford Univ. Press, 1943.)

Health Education

Under the Public Health Act, 1936, Sect. 179, any local authority or county council may arrange for the publication within their area of information on questions relating to health or disease and for the delivery of lectures and the display of pictures, etc., dealing with such matters. The following are the principal methods of propaganda in this country :—

(1) Newspaper publicity.
(2) Other written propaganda, bulletins.
(3) Leaflets.
(4) Posters.
(5) Lectures illustrated by lantern slides or films.
(6) Broadcasting.
(7) Health teaching in schools.

Newspaper publicity—most valuable; articles should have attractive titles and be written in a popular style and signed.

Bulletins—much used in U.S.A.; issued free or at nominal cost.

*Leaflets** dealing with advice to expectant mothers and with such subjects as infant feeding, care of the teeth, diphtheria immunisation—useful for distribution at ante-natal clinics and at maternity and child welfare centres. Another helpful addition would be the issue of a booklet on health services to be taken home by children on their first day of attendance at school. The printed matter should be set out clearly without overcrowding and should deal with essentials only. Large type should be used where necessary. Leaflets badly printed and on cheap paper are of no value.

*Posters** should be confined to a single subject; choice of site, colour, design, wording and size of print need careful consideration. Posters are costly to produce, and whether the return is commensurate with the outlay is a matter of opinion.

Lectures may be given to selected audiences, *e.g.* health visitors, nurses, etc., or they may be popular lectures illustrated by lantern slides or films. The illustrated popular lecture is a useful means of propaganda provided a good lecturer is available, a suitable subject has been chosen and the lecture is not too long. Though the lecture should be of the nature of a " talk " and not too technical, it is well not to under-estimate the intelligence of the audience. Questions should be encouraged.

Films play a very important part to-day in education in all its branches and not least in that relating to health. While the standard size (35 mm.) is used for instructional films produced by large commercial undertakings and shown in cinemas, the substandard size (16 mm.), either sound or silent, is the most useful for health education purposes. It has the advantage that as the films are manufactured from slow-burning material, known as "non-flam," they can be shown in halls which do not comply with the usual " safety-from-fire " regulations. There is a variety of portable apparatus on the market, and most educational films are produced for the sub-standard size of projector. Films may be silent, sound on film, or synchronised sound on disc. The best type of silent apparatus is one that can be stopped at any point for explanation. Films can be made to show some of the activities of a local authority. Standard films can be reduced to substandard size. The use of travelling cinemas for health propaganda has many advocates, though running expenses are by no means negligible. The medical panel of the British Film Institute has compiled a catalogue of British films dealing with medical and public health subjects; information is given as regards owner-

* Obtainable from the Central Council for Health Education.

ship and whether the particular film can be hired. A supplementary list of films made in the tropics has also been prepared. The Central Council for Health Education publish a list of some 250 16 mm. films both sound and silent, which are available either direct or through their affiliated societies. In addition to films produced by the Council itself, copies of other health films produced by such authorities as the United States Department of Public Health can also be obtained on loan by arrangement. Though films are most useful to illustrate lectures, the value of lantern slides should not be forgotten. The standard size of slide in this country is 3¼ in. square. The taking of still pictures on a 35 mm. cinematograph film has led to the standardization of a 2 in. square slide, and to the preparation of transparencies in the form of strips of 35 mm. film. A recent development in the 3¼ in. slide, of particular interest to schools, is the fact that drawings and diagrams may be made by the teacher on cellophane (*non-waterproof*) and sandwiched between two lantern slide cover plates. The method of preparation is described in "Teaching with School Projectors," published by the British Film Institute, 1943.

Broadcasting commands a larger audience than any other method of propaganda, and ten-minute health talks may be given.

Health education among school children may be carried out by an experienced teacher, films shown, health plays acted and posters designed.

Health weeks and exhibitions stimulate local interest in health matters, but lose their appeal if held too frequently.

During a health week arrangements should be made to enable the public to see some of the activities of the local authority, such as clean milk production, infant welfare centres, nursery schools, diphtheria immunisation, etc., and short lectures may be given. Health exhibitions have been placed in three categories by the Central Council for Health Educaiton.

1. The small exhibition for a moderate-sized town or rural district. This is complete, but on a miniature scale.

2. The special exhibition for a particular object—*e.g.* baby week, social hygiene or dental hygiene—undertaken by the organisation concerned. Here the principal theme is fully developed, while other health subjects are regarded as of secondary importance.

3. The large health exhibition for a city. This should contain all the principal subjects as outlined below. It should have the various departments of the local authority's work well in evidence, *e.g.*, maternity and child welfare, tuberculosis, housing, school hygiene, etc. In adjacent halls or rooms there should be suitable lectures and film demonstrations.

The following subjects should be dealt with in any health exhibition :—

1. Eugenics.
2. Maternity and child welfare.
3. School hygiene and dental care.
4. Tuberculosis.
5. Social hygiene, including venereal diseases.
6. History of medicine, including demonstration of the latest progress in scientific warfare against disease, *e.g.*, diphtheria immunisation.
7. Housing and environmental hygiene.
8. A special department devoted to positive health teaching and personal hygiene, *e.g.*, the value of sunlight, fresh air, sleep, the essentials of normal nutrition, cleanliness.

If it is necessary to introduce trade exhibits to help to defray expenses, they should not predominate so as to mask the main object of the exhibition, and no more than 40 per cent. of the stall space should be allotted to this purpose.

The Central Council for Health Education is an incorporated body whose main function is the promotion and co-ordination of health education throughout the country by advice as well as by financial assistance. Its members include representatives of the Minister of Health, Board of Education, Associations of Local Authorities, Insurance Committees and Friendly Societies, the British Medical Association, the British Dental Association, the Dental Board of the United Kingdom, the Society of Medical Officers of Health, and the Conference of Affiliated Societies engaged in health education work. This organisation issues monthly a useful little publication called *Better Health*, which is distributed by many local authorities in their areas, and in addition publishes quarterly the *Health Education Journal*. This forms a useful medium for keeping doctors, teachers, club leaders and others informed on the best methods of approach to current problems in health education and for giving them up-to-date details of such facilities as propaganda films, pamphlets and leaflets.

THE COLLECTION OF VITAL STATISTICS

The medical officer of health is not in a position to appraise the health of the inhabitants of his area or to compare conditions in one district with those in another unless he has at his disposal certain essential statistical information. Some of this information he collects himself, some of it is provided for him by the Ministry of Health. It is also his duty to send weekly to the Ministry the number of notifications of cases of infectious disease he has received during the preceding week,

and to complete every year certain statistical tables which should appear in his annual report.

The main sources of statistical information available to a medical officer of health are :—

(1) The census, taken in the past every ten years, but in future (possibly) every five.

(2) Registration of births, deaths, and marriages.

(3) Notification of births made to the medical officer of health by medical practitioners, midwives, or parents within his own area.

(4) Notification of cases of infectious disease.

(5) Figures collected by his own staff in connection with the maternity and child welfare, school medical and other services.

(6) Various hospital returns, and morbidity statistics of insured persons under the National Health Insurance scheme.

The Government department concerned with the collection and tabulation of vital statistics is the General Register Office established by the Births, Deaths, and Marriages Registration Act, 1836. This office is now part of the Ministry of Health. The information furnished to each medical officer of health by the Ministry of Health for the purposes of his annual report consists of :—

(1) A mid-year estimate of the population of his area.

(2) Number of births and deaths in his area, after making allowance for those transferable. (The Registrar-General tabulates births according to the parents' usual place of residence and not according to where the birth occurs. In the same way deaths are attributed to the district in which the deceased person lived, irrespective of where he died.)

(3) Causes of death, distinguished by sex and age.

(4) Number of notified cases of the chief infectious diseases.

The Law relating to the collection of certain vital statistics

Census Act, 1920. This Act provides that it shall be lawful for His Majesty by Order in Council to direct that a census shall be taken for Great Britain or for any part of Great Britain, provided that (1) at least five years have elapsed from the date when a census was last taken and (2) that no particulars shall be required other than particulars relating to :—

(*a*) Name, sex, age.

(*b*) Occupation, profession, trade, or employment.

(*c*) Nationality, birthplace, race, language.

(*d*) Place of abode and character of dwelling.

(*e*) Condition as to marriage, relation to head of family, issue born in marriage.

(*f*) Any other matters with respect to which it is desirable to obtain statistical information with a view to ascertaining the social or civil condition of the population.

It is the duty of the Registrar-General to carry out the census; to prepare reports on the returns; to provide abstracts, if he thinks fit, at the request of any local authority or person; and to collect and publish any available statistical information relating to the number and condition of the population between one census and another.

A local authority may at any time, on application to the Minister of Health, obtain an Order in Council directing that a census may be taken for the whole or part of their area. The local authority must bear the cost.

In 1930 the Minister of Health issued Provisional Regulations with respect to the detailed proceedings for taking census. (Prior to 1920 a separate Act had to be passed enabling each census to be taken.)

Registration of Births and Deaths Acts, 1874 and 1926. These Acts provide for the registration of births within forty-two days and of deaths, ordinarily, within five days. Registrars are appointed by the councils of counties and of county boroughs. A medical practitioner who has attended a person during his last illness must give a certificate of death. When an inquest is held a coroner's certificate is given. The death certificate must state the immediate cause of death and any other morbid condition (if important) contributing to death, and the certificate should be delivered by the medical practitioner to the registrar. The medical practitioner must also give to the person required to register the death a notice in writing stating that the death certificate has been signed. This procedure has been adopted in the hope that the medical practitioner will feel at liberty to state more freely the exact cause of death. The registrar, on registering a death, must give a certificate of registration. No body may be buried except on the certificate of a registrar or on a coroner's order.

The Population (Statistics) Act, 1938, came into force in June, 1938, for a period of ten years. Amongst other things it will facilitate the compilation of more accurate statistics on fertility than has hitherto been possible as a birth can now be correlated with the age of the mother, the duration of marriage and the total age and size of the family.

Still-births have been registrable since 30th June, 1927, *i.e.* any child which has issued forth from its mother after the twenty-eighth week of pregnancy and which did not, at any time after being completely expelled from its mother, breathe or show any other signs of life.

Births thus fall into three classes :—

(*a*) A child who, whatever the period of the pregnancy,

breathes or shows any other signs of life after complete expulsion is live-born and the birth must be registered. If the child dies even within a brief period only after birth, both birth and death must be registered.

(b) The birth of a child before the end of the twenty-eighth week of pregnancy which did not breathe or show any other signs of life need not be registered.

(c) All still-births as defined above must be registered.

A still-born child may not be buried until a certificate of the registration has been obtained. Relatives registering a still-birth must either (1) deliver to the registrar a written certificate that the child was not born alive, signed by a medical practitioner or by a certified midwife who was in attendance at the birth or who has examined the body of the child; or (2) make a declaration on the prescribed form that no medical practitioner or certified midwife was present at the birth or has examined the body or that his or her certificate cannot be obtained, and that the child was not born alive.

It must be remembered that registration of births is quite distinct from the notification of births to the medical officer of health (see p. 246). (Registration (Births, Still-births, Deaths and Marriages) Consolidated Regulations, 1927 and 1930, and Circulars 802 and 802A, Ministry of Health, 20th June, 1927.)

Notification of infectious and other diseases. Since 1899 medical practitioners have been required to notify certain infectious diseases to the local medical officer of health, and since 1895 certain industrial diseases to the Chief Inspector of Factories at the Home Office (see pp. 145 and 667).

Enumeration of the Population

Census taking. The first complete census was taken in this country in 1801. Since then the census has been taken at intervals of ten years; it is now possible to take a census every five years. As the people are actually enumerated, this method is the most accurate. In addition to this advantage other facts, useful for statistical purposes, can at the same time be determined. The amount of information obtained has increased with each succeeding census. In 1931 each householder had to complete the following schedule for all those resident in his house:—

Name.
Relation to head of household.
Usual residence.
Sex.
Age in years and months.
Whether married, unmarried, widowed or divorced.
Particulars as to profession or occupation. Whether employer, employed or working on own account.
Name of present or last employer, and employer's business.

Place of work, with address.
Whether occupied in full-time or part-time attendance at an educational institution.
Birthplace.
Nationality of persons not born in the United Kingdom.
Number of rooms.
Language spoken (Wales and Monmouth only).

The errors in connection with this method are: Adults are sometimes ignorant of their precise age; ages are often stated in round numbers or as multiples of 10, or wilfully misstated; old people are apt to overstate their age; and children's ages are vaguely returned.

POPULATION OF ENGLAND AND WALES

Year.	Males.	Females.	Persons.
1801	4,254,735	4,637,801	8,892,536
1851	8,781,225	9,146,384	17,927,609
1901	15,728,613	16,799,230	32,527,843
1931	19,138,844	20,809,087	39,947,931

The census is taken as a rule at the end of the first quarter of the year, and from the figures obtained the mid-year population is calculated. If the census were taken in the middle of the year seaside towns and other summer resorts would show excessive populations. The *de facto* population is that actually enumerated at any place; the *de jure* population is the figure obtained after each person has been referred to his usual place of residence.

Estimation of Population for Inter-censal Periods

(*a*) *Allowance for births, deaths and migration.* In recent years this method has been adopted for inter-censal periods. Supposing the mid-year population for 1926 is required. The 1921 census population is taken, and to it are added the births and immigrants, and from it are subtracted the deaths and emigrants, between the date of the census and 30th June, 1926: the result is the population for 1926. The system of registration of births and deaths in this country provides a very complete record, so that the natural increase of population can be accepted, as the errors are insignificant when taken in relation to the whole population. But this cannot be said of the migration element. Information regarding the movements of individuals is not so complete. The accuracy of this method will depend, then, upon the knowledge obtained of the numbers of persons entering and leaving this country each year.

(*b*) *The inhabited house method.* The population by this method is the product of the number of inhabited houses in the area as calculated from the rate-books, and the average number

of persons occupying each inhabited house as obtained from the last census.

(*c*) *Method of arithmetic progression.* This method is usually accurate enough for all practical purposes. Suppose the census population of a town was 980,000 in April, 1931, and 950,000 in April, 1921, and an estimate is required for the middle of 1935. It is assumed that the same annual increase between the 1921 census and 1931 census continued after 1931.

980,000 = population in 1931.
950,000 = ,, 1921.

∴ 30,000 = increase in 10 years.
3,000 = increase in 1 year.

Hence the population in April, 1935 $= 980{,}000 + (3{,}000 \times 4)$ $= 992{,}000$.

As the census was taken in April, a quarter of the annual increase is added to bring the estimated population up to the middle of the year 1935.

∴ Population in middle of 1935 $= 992{,}000 + (3{,}000 \times \frac{1}{4})$ $= 992{,}750$.

(*d*) *Method of geometric progression* (making use of logarithms). Since population begets population it may seem more reasonable to assume that the population increased by geometric progression (after the manner of compound interest) than that it increased by arithmetic progression (after the manner of simple interest). For instance, if a population were found to have increased from 100,000 to 121,000 in one year, it would appear more likely that about 10,000 had been added in the first half of the year and 11,000 in the second half, than that 100,000 had increased by 10,500 in the first half of the period and 110,500 had increased by no more than 10,500 in the second half. Quantities are said to be in geometric progression when they increase or decrease by a constant factor or common ratio. Thus each of the following series forms a geometric progression :—

3, 6, 12, 24 (common ratio = 2)
a, ar, ar^2, ar^3 (,, ,, $= r$)

A geometric increase of population is calculated as follows :—

Let x = population in April, 1921
,, y = ,, ,, 1931
,, R = common ratio
,, n = number of terms of years.

Then $y = x\mathrm{R}^n$.

That is, $\log. y = \log. x + n \log. \mathrm{R}$,

$$\therefore \log. \mathrm{R} = \frac{\log. y - \log. x}{10}$$

∴ log. of population in middle 1936 $= \log. y + 5{\cdot}25 \log. \mathrm{R}$

Example. The population of A at the census in April, 1931, was 142,427, at the previous census in April, 1921, the population was 131,237. Estimate the population in the middle of 1936, assuming that the geometric rate of increase between 1921 and 1931 continued afterwards.

Population in 1931	= 142,427	Log. of pop.	= 5·1535924
,, 1921	= 131,237	,, ,,	= 5·1180563

$\therefore$ 10 log. r = ·0355361
$\therefore$ log. r = ·0035536

$\therefore$ Log. of population in middle of 1936
= 5·1535924 + 5·25 (·0035536)
= 5·1722488

$\therefore$ Population in middle of 1936 = 148,679.

The population of A estimated according to an arithmetic progression would be :—

Population in 1931 = 142,427
,, 1921 = 131,237

Increase in 10 years = 11,190
,, 1 year = 1,119
$\therefore$ Population in 1936 = 142,427 + (5·25 × 1,119)
= 148,302

1931 Census, England and Wales

AGE CONSTITUTION OF THE POPULATION

	1931	1901
0— 4 years . .	7 per cent.	11 per cent.
5—14 ,, . .	16 ,, ,,	21 ,, ,,
15—24 ,, . .	17 ,, ,,	20 ,, ,,
25—49 ,, . .	37 ,, ,,	33 ,, ,,
50 + ,, . .	23 ,, ,,	15 ,, ,,

Proportion of females per 1,000 *males.*

England and Wales . .	1,087
All urban areas . . .	1,106
All rural areas . . .	1,016

Density (1931)

80 per cent. of the total population live in urban areas—40 per cent. of the population live in the 51 towns having a population of over 100,000, and 25 per cent. in the 245 towns with a population of from 20,000 to 100,000.

Number of persons per acre.

England and Wales .	1·1 (= 685 persons per sq. mile)
All urban areas . .	7·1
All rural areas . .	0·2
London Administrative County . .	58·7
All county boroughs .	17·5
Greater London . .	18·5

Number of structurally separate dwellings —9,400,000.

i.e. "Any room or suite of rooms intended or used for habitation having separate access to the street or to a common landing or staircase to which visitors have access."

Size of dwellings.

1—3 rooms	15·4 per cent.
4—5 ,,	52·6 ,, ,,
6—8 ,,	27·4 ,, ,,
9 +	4·6 ,, ,,

Average unit of occupation = 4·5 rooms (4·55 in 1921).

Size of families. (Total number = 10,233,000.)

1—3 persons . .	52·7 per cent.
4—6 ,, . .	39·1 ,, ,,
7 + ,, . .	8·2 ,, ,,

Average size of family = 3·72 persons (4·14 in 1921).

Average number of persons per room = 0·83 (0·91 in 1921).

Living more than 2 persons per room	6·9 per cent. of population (9·6 in 1921), or 3·88 per cent. of families (5·69 in 1921).

Shoreditch had an average number of persons per room of 1·45, Gateshead 1·23, Bournemouth 0·64, and Hampstead 0·70. More than 50,000 families were living at densities of 4 or more persons per room, and more than 180,000 at densities of 3 or over. These two groups together form 1·8 per cent. of all families.

It will be noted that density of population may be expressed as the number of persons per acre, per square mile, or per room. The ratio of more than two persons per room has been selected by the Registrar-General as an approximate index figure for the purpose of measuring the prevalence and distribution of overcrowding.

An excellent review will be found in the "Housing Report and Tables," Census of England and Wales, 1931, published by H.M. Stationery Office in 1935.

Death rates. The *crude* death rate of a given region or locality represents the number of deaths which were registered during the year as belonging to that locality, after correction for transfers to the place of residence of the deceased, per 1,000 or million of the corresponding estimated population at the middle of the year. In this rate are included deaths at all ages whatsoever.

$$\frac{\text{No. of deaths registered in the year} \times 1000}{\text{mid-year population}}$$

It is needless to say that any rate, calculated upon a period of time less than a year, is apt to overstate or understate the true rate. For it does not follow that the number of deaths for the whole year will be four times the number occurring in any quarter, or thirteen times the monthly number, or fifty-two times the weekly number.

Specific death rates, *e.g.*

$$\frac{\text{No. of deaths in age period 0–4 years} \times 1000}{\text{population at ages 0–4 years}}$$

relate (1) to mortality assigned to specific causes or (2) to the mortality amongst selected groups of persons specified according to their sex, age, civil condition or occupation. Specific rates of the second type are, with certain exceptions, obtained by relating the numbers of deaths registered as being those of persons in the selected group to the estimated number of such persons alive at the mid-year. Exceptions to this are the rate of infant mortality which is based upon the number of live births registered during the year, and certain death rates connected with childbearing which are based upon the number of live- and still-births registered during the year.

The highest mortality occurs at the two extremes of life, and as a whole females have the lower death rate; urban areas, being for the most part industrial centres, have a bigger proportion of people living in the middle-age periods of life, ages at which the death rates are low; and rural areas have a greater number of old people. Some correction must be made for these irregularities of distribution as regards age and sex, otherwise the death rates will afford no accurate means of comparing the healthiness of one district with that of another. The death rate so adjusted is known as the *standardised* death rate. "Standardised death rates are attempts to express the mortality of a population of changing or abnormal age distribution by a single figure calculated in such a way that the changes or abnormalities in constitution do not appreciably affect it. The standardised rates used by the Registrar-General in his Statistical Review of England and

Wales, whether for all causes or specific causes, are the rates which would result if each sex and age group of the census population in 1901 was subject to the death rate at that age during the year to which the rate applies." (The reader should consult "An Introduction to Medical Statistics," Woods and Russell, P. S. King & Son Ltd., 1936, as to methods of standardising death rates.)

Combined death rate. A town with a population of 56,000 has a death rate of 18 per 1,000; an adjacent town has a population of 11,000, and a death rate of 10 per 1,000. What is the death rate for the combined areas?

It is not the mean of the two rates 18 and 10, namely 14, as the populations are not the same;

but—

$$\frac{\dfrac{56{,}000 \times 18}{1000} + \dfrac{11{,}000 \times 10}{1000} \times 1000}{56{,}000 + 11{,}000}$$

That is, it is the sum of the total deaths in each town which is then expressed as a rate per 1,000 of the combined population.

$$= \frac{(1008 + 110) \times 1000}{67{,}000} = 16{\cdot}7$$

All death rates are calculated upon the entire population, unless the disease for which the death rate is being sought has a special age or sex incidence.

Thus the **Infant mortality rate** for any year =

$$\frac{\text{No. of deaths of infants under one year} \times 1000}{\text{No. of registered live-births}}$$

and the **Maternal mortality rate** =

$$\frac{\text{No. of deaths of women classed to pregnancy or childbirth} \times 1000}{\text{No. of registered live- and still-births}}$$

(See pp. 235 and 241.)

Marriage rate $= \dfrac{\text{No. of marriages} \times 1000}{\text{mid-year population}}$

Although this is the usual method of calculating the marriage rate, it is not exact for purposes of comparison, unless the age constitution of each district is the same. It would be more correct to return the rate as the number of marriages per 1,000 unmarried persons aged 15 years* and over. In 1930 the mean age at marriage was 27·33 years for bachelor bridegrooms and 25·5 for spinster brides, representing a postponement since 1896 of 0·7 year for bachelors and 0·4 year for spinsters.

* The Age of Marriage Act, 1929, prohibits any marriage where either party is under 16 years of age.

Birth rate $= \dfrac{\text{No. of births in the year} \times 1000}{\text{mid-year population}}$.

This may give a false idea of fertility. The number of children born depends upon the number of married women. Therefore the Fertility Rate

$$= \frac{\text{No. of legitimate births} \times 1000}{\text{No. of married women between } 15^*\text{–}45 \text{ years}}$$

(See *Statistical Review of the Registrar-General*, 1930, pp. 121–123.)

As this does not include the illegitimate births, a separate birth rate is calculated.

Thus **Illegitimate birth rate**

$$= \frac{\text{No. of illegitimate births} \times 1000}{\text{No. of unmarried women and widows between 15–45 years}}$$

Sometimes the illegitimate births are expressed as a proportion of the total births—5·37 per cent. in 1942. If the legitimate birth rate is declining, there will be an apparent, but possibly not a real, increase in illegitimacy.

Still-births. In 1942 the proportion of still-births in England and Wales was 33 per 1,000 total births. The figure was highest in Wales and lowest in the South East of England.

Natural increase of the population means the excess of births over deaths in any one year. This rate of increase per 1,000 population fell in England and Wales from 15·4 in 1876 to 4·2 in 1942.

Occupational mortality. It is important that we should have at our disposal a reliable method of comparing the "healthiness" of one occupation with that of another, and this problem is dealt with in detail in the Registrar-General's Decennial Supplement (England and Wales), 1931, Part II.a, published in 1938.

It is obvious that occupational groups vary widely. Some occupations demand great physical strength while others are open only to persons of certain ages. The differences in age distribution are perhaps the most important, hence crude death rates cannot be a reliable measure of the environmental risks. Some form of standardisation is necessary. In the Report various forms have been applied and all give closely similar results. The method most frequently adopted is that of the **standardised mortality ratio (S.M.R.)**. This figure is the ratio of the deaths actually occurring in an occupational group in the years 1930–32 to the deaths that would have occurred if that group had experienced the death rates at ages which were the lot of all males in England and Wales in the same calendar years. For instance, at ages 20–65 years, 5,693 deaths of male farmers and their relatives were registered in 1930–32. But

* The Age of Marriage Act, 1929, prohibits any marriage where either party is under 16 years of age.

if the population of this group, as recorded at the census of 1931, had experienced the death rates of all males in 1930–32, then it would have recorded 7,801 deaths. In other words, allowing for the particular age distribution of male farmers and their relatives, the actual mortality of the group was only 73 per cent. of its " expected " mortality, using the experience of all males as the standard of comparison. The standard mortality ratio is, therefore, 73. These ratios have been calculated for two age groups, 20–65 and 35–65, and in the same way for many specific causes of death.

Another and older method of standardisation is that of the **comparative mortality figure (C.M.F.)**. Here a standard population is first selected and the death rates at separate ages experienced in the occupations are applied to that population. The standard populations appropriate for 1930–32 are the census populations of all males, all married or single women at ages 20–65 reduced to totals which produce 1,000 deaths when the standard rates from all causes are applied to them. These standard populations are :—

	20–	25–	35–	45–	55–65	20–65
Males . .	17,436	31,422	25,779	23,630	18,116	116,383
Married women	8,837	42,238	42,598	36,360	23,259	153,292
Single women .	70,185	58,245	30,193	22,700	16,144	197,467

If the death rate for medical practitioners (or whatever trade or profession is to be compared) for each of these age groups is applied to the corresponding age group of the standard population, the sum of the deaths thus calculated will be the number which would have occurred in 116,383 males if they had all been medical practitioners. For convenience of comparison with the standard mortality rate the comparative mortality figure is divided by 10 in the Registrar-General's tables.

At ages 20–65 only 4 male occupation groups out of 88 show differences between the S.M.R. and the C.M.F. exceeding 5 units. The two methods of standardisation are quite comparable.

In the past the available statistics have been limited to the mortality experienced by males in different occupational and social groups. The analysis is now extended to cover the mortality experienced by the wives of these men. Where an excess of mortality amongst males is found, it is now possible to see whether the excess is likely to be occupational in origin or whether it is rather a concomitant of the occupation, derived from a social environment outside the occupation, which is shared by the wives. If, for instance, the males employed in

a particular occupation show a relatively high death rate from tuberculosis and this disadvantage is not apparent amongst the wives, then an occupational origin of that high rate may well be suspected. If, on the other hand, wives as well as husbands labour under an unduly high rate, it seems more likely that some other factor is at fault, such as their common social environment or standard of living.

In addition, the Registrar-General has introduced for the first time some mortality rates experienced by single women engaged in different occupations, comparisons of death rates according to social class in different parts of the country, and a study of the mortality of children aged one to two years according to the occupation or social class of the parents.

The Registrar-General's Decennial Supplement (England and Wales), 1921, Part II., for the first time distinguished occupations on purely occupational lines. The effect of this was to accentuate contrast between the mortalities of the occupations compared. Previously the records for an unhealthy occupation had been diluted by inclusion of those for other workers, industrially or otherwise related, but not subject to the same occupation risk. Thus cutlery grinders, who are subject to a special silica risk, were formerly grouped with all others in the manufacture of cutlery, many of whom are subject to no special risk, under the heading of " cutler, scissors maker," with the result that the mortality of the composite group in 1910–12 exceeded the average by 63 per cent. For 1921–23, however, figures were given relating to the actual grinders of cutlery (*i.e.* men classed *occupationally* as metal grinders and *industrially* as employed in the cutlery trade), and it was found that the corresponding excess of their mortality was no less than 230 per cent.

From all causes of death the four occupational groups with the most unfavourable experience (out of 198 groups) are tin and copper mine workers below ground, sandblasters, other metalliferous mine workers below ground, and stevedores with standardised mortality ratios of 342, 304, 283, and 220. The first three of these groups share an extremely high death rate from respiratory tuberculosis, and from diseases of the respiratory system including chronic interstitial pneumonia. The four occupations with the most favourable experience are agriculture machine workers and foremen, wireless operators and telegraphists (not seagoing), makers of non-metalliferous mine and quarry products, and draughtsmen, costing clerks, with mortality ratios of 55, 63, 64 and 65. Cotton strippers and grinders exposed to the dust of the cardroom continue to show an excess from diseases of the respiratory system, though it is rather less pronounced than in 1921–23. Phthisis remains an unduly important cause of death throughout the working life

of skilled boot and shoe factory operatives and continues to cause a relatively high mortality amongst printers. Tram drivers and omnibus and tram conductors show a slightly enhanced mortality from peptic ulcer which was not present in 1921–23. Physicians and surgeons show a total mortality not very different from that of all males, but division by cause of death gives significant excesses under angina pectoris, the group of "other diseases of the digestive system," and appendicitis. For digestive diseases as a whole their ratio is exceeded by only one occupational group—innkeepers—but on the other hand their rates from cancer and phthisis are very favourable. Their wives, it is interesting to note, have a normal rate for digestive diseases.

The following table gives the **standard mortality rate** for males following certain occupations, and for their wives (ages 20–65) :—

	Males.	Wives.
Farmers and their relatives	73	90
Coal hewers and getters	113	140
Potters ; ware-makers, etc.	135	102
Textile spinners, cotton	105	124
Makers of alcoholic drinks	121	96
Dock labourers	137	131
Clergymen (Anglican)	69	85
Physicians, surgeons, etc.	106	79
Inn, hotel keepers, etc.	155	117

The highest standard mortality rates for single women are among costermongers and hawkers (200), textile spinners and piecers (159), potters, ware-makers, etc. (148), milliners and hat formers, sewers, etc. (133), charwomen, office cleaners (126); whilst the lowest are among telephone operators (45), telegraph operators (48), teachers (62), hairdressers (63), typists and other clerks (68).

Case mortality or **fatality rate** is the percentage number of deaths among those attacked by any given disease. It is the only rate not calculated per 1,000. The severity of an epidemic can be measured in this way.

Example. In a population of 50,000 there were 200 cases of typhoid fever, of whom 30 died.

$$\text{Death rate} = \frac{30 \times 1000}{50{,}000} = 0{\cdot}6 \text{ per } 1000.$$

$$\text{Case mortality} = \frac{30 \times 100}{200} = 15 \text{ per cent.}$$

The morbidity rate is the number of persons suffering from any disease multiplied by 1,000 and divided by the population.

In the above example, $\frac{200 \times 1000}{50,000} = 4$ is the morbidity rate of typhoid fever.

N.B. The rates which are the most sensitive indices to the social conditions of an area are the infant mortality rate, the phthisis death rate and the standardised death rate.

Life Tables

The mortality experience of a community can be very interestingly represented by a life table, which presents the statistics in a form easily understood by students of public health.

The ideal life table is one in which a number of children, all born on the same day, are kept under observation until they have all died. This involves nothing more than a simple task in book-keeping, in which there are two columns, the one (commonly called the l_x column) records the numbers alive on the successive anniversaries of their birth, the other (the d_x column) contains the numbers who died before reaching the various anniversaries. From the particulars in these two columns all the other details usually published in a life table can be readily obtained, the calculation being purely mechanical.

In making a national or local life table we are not, however, in the position of being able to record the history of a generation from birth to death in the manner just described, and it is necessary to adopt another procedure. It is possible to ascertain the population living at individual ages (this is usually given for the whole country in the census reports), as well as the deaths at these individual ages. From these data, population and deaths, we can, with a little adjustment, calculate values called q_x—the probability that a person aged x years will die before reaching the age $x + 1$ years. Having obtained the values of q_x for each age (this column is the key to the construction of a life table), the corresponding values of p_x, which measures the probability that a person aged x will reach his next birthday, can be at once obtained, because

$$p^x = 1 - q_x.$$

Operating preferably on the values of p_x, we can then calculate the number of survivors at each age. It is this column containing the survivors which is the most important section of a life table so far as public health authorities are concerned. For the first five years of life it must be noted, however, that the values of q_x are obtained from the *births* and deaths, and not from the *population* and deaths, as it has been found that the census enumeration of the population at ages under five years is not very satisfactory. The number of survivors at each age having been obtained, the total years of life they may be expected to live (usually designated T_x) and their average expectation of life (that is, T_x divided by l_x at the corresponding ages) can be readily obtained.

The foregoing is a rough outline of the steps necessary to construct a life table. For a detailed description of the method and the appropriate formulæ employed, students are recommended to read the description given by King in his construction of the National Life Table officially called E_7, and based on the mortality data for the years 1901–1910. (Supplement to the Seventy-Fifth Annual Report of the Registrar-General, Births, Deaths and Marriages in England and Wales, Part I., Life Tables, 1914.)

An extract of this particular life table is given in Table A. From the values of p_x in col. 3 the number of survivors in col. 4 were

TABLE A.

ENGLISH LIFE TABLE NO. 7, MALES, 1901–1910.

Age$_x$	q_x	p_x	l_x	d_x	L_x	T_x	$e°_x$	Age$_x$
Col. 1.	Col. 2.	Col. 3.	Col. 4.	Col. 5.	Col. 6.	Col. 7.	Col. 8.	
0	0·1443427	0·8556573	1,000,000	144,343	893,851	48,533,893	48·53	0
1	0·0403923	0·9596077	855,657	34,561	838,377	47,640,042	55·68	1
2	0·0159494	0·9840506	821,096	13,097	814,547	46,801,665	57·00	2
3	0·0100189	0·9899811	807,999	8,095	803,952	45,987,118	56·92	3
4	0·0074045	0·9925955	799,904	5,923	796,942	45,183,166	56·49	4
5	0·0054248	0·9945752	793,981	4,307	791,828	44,386,224	55·90	5
6	0·0039788	0·9960212	789,674	3,142	788,103	43,594,396	55·21	6
7	0·0029745	0·9970255	786,532	2,340	785,362	42,806,293	54·42	7
8	0·0023280	0·9976720	784,192	1,825	783,279	42,020,931	53·59	8
9	0·0019645	0·9980355	782,367	1,538	781,598	41,237,652	52·71	9

q_x Probability of dying within a year.
p_x Probability of living one year.
l_x Born and surviving at each age.
d_x Deaths between age x and $x + 1$ years.
L_x Population or years of life lived in each year of age.
T_x Population or years of life lived in and above each year of age.
$e°_x$ Mean after-life time or expectation of life at each age.

estimated. Thus, starting with 1,000,000 male births, the number who will reach their first birthday is 855,657 (obtained by multiply-

TABLE B. TABLE C.

Age.	1871–80 l_x	1901–10 l_x	1920–22 l_x	1930–32 l_x	1871–80 $e°_x$	1901–10 $e°_x$	1920–22 $e°_x$	1930–32 $e°_x$
	Males.							
	Giving the number of survivors, l_x, at each age out of 100,000 born in England and Wales at different periods.				Showing the expectation of life in England and Wales at different periods.			
0	100,000	100,000	100,000	100,000	41·35	48·53	55·62	58·74
5	73,407	79,398	86,955	90,069	50·87	55·90	58·81	60·11
15	69,642	77,296	84,915	88,360	43·41	47·31	50·12	51·19
25	65,708	74,546	82,202	85,824	35·68	38·86	41·60	42·54
35	59,886	70,472	78,634	82,885	28·64	30·79	33·25	33·87
45	52,237	64,230	73,436	78,357	22·07	23·27	25·22	25·51
55	42,468	54,435	65,161	70,041	15·95	16·48	17·73	17·89
65	29,716	39,278	50,255	54,899	10·55	10·80	11·36	11·30
75	14,496	19,753	27,107	29,665	6·34	6·41	6·59	6·43
	Females.							
0	100,000	100,000	100,000	100,000	44·62	52·38	59·58	62·88
5	76,262	82,178	89,182	92,024	53·08	58·53	61·67	63·24
15	72,496	79,898	87,067	90,420	45·63	50·08	53·06	54·28
25	68,486	77,390	84,553	88,133	37·98	41·54	44·48	45·55
35	62,884	73,769	81,314	85,353	30·90	33·31	36·05	36·87
45	56,017	68,359	77,109	81,660	24·06	25·53	27·73	28·30
55	47,744	60,179	70,360	75,290	17·33	18·27	19·86	20·23
65	35,617	46,716	58,027	63,046	11·42	11·99	12·90	13·07
75	19,057	26,418	36,002	40,040	6·87	7·10	7·49	7·45

ing 1,000,000 by ·8556573, this latter figure being the probability that a child will live a year in the first year of life). Similarly, 855,657 × ·9596077 = 821,096 will be the number of males who will reach exact age two years, and so on for the other ages until there are no survivors left. The numbers in col. 5 relate to those who died between the age of x and $x + 1$ years, and the total of the entries in this column will, of course, be 1,000,000 since it must equal the number of births with which we started, *i.e.* 1,000,000. Col. 6 contains the population which would remain stationary in its age constitution if 1,000,000 males were born uniformly throughout each calendar year, provided it were unaffected by emigration

ENGLAND AND WALES

Period.	Birth rate.	Annual number of births.	Estimated population.	Annual number of deaths.	Death rate.	Infant mortality rate.
1871–1880	35·4	858,878	24,225,271	517,831	21·4	146
1881–1890	32·4	889,024	27,384,934	524,477	19·1	142
1891–1900	29·9	915,515	30,643,316	557,538	18·2	153
1901–1910	27·2	929,821	34,180,052	524,877	15·4	128
1911–1920	21·8	809,622	35,682,500	518,805	14·4	100
1921–1930	18·3	712,907	38,934,000	472,299	12·1	72
1934	14·8	597,642	40,467,000	476,810	11·8	59
1938	15·1	621,204	41,215,000	478,829	11·6	53
1939	14·9	619,352	41,246,000	498,968	12·1	50
1942	15·8	654,039	—	480,131	11·6	49

(The rates for 1942 are based on the 1939 population.)

or immigration, and it were subjected to the rates of mortality appearing in col. 2. It can also be represented as showing the years of life lived in any year of age. For instance, 789,674 males attained exact age six years, and of this total the number who lived another full year was 786,532 (those who reached precise age seven years), but of course those who died between age six and seven years, viz. 3,142, lived some time in the year in which they died. It is usual to assume that they lived half a year. Hence the total years lived between six and seven years is 786,532 plus $\frac{1}{2}$(3,142) = 788,103 years, and so on for the other ages. The figures in col. 7 represent the summation of the values in col. 6 at and above each age. Thus the number of years of life lived by the 1,000,000 males who were born is 48,533,893. Another interpretation of the figures is that the total population which would be generated and kept constant or stationary as to numbers by 1,000,000 male births, if the rates of mortality were those in col. 2, would be 48,533,893. The last column of the table gives particulars of the average number of years that the males in col. 4 may be expected to live if the rates of mortality on which this particular life table was based still apply in the future: 1,000,000 males born have, on the average, an expectation of 48·53 years (48,533,893 divided by 1,000,000), and children who have already attained age five years may hope for an additional 55·90 years (44,386,224 divided by 793,981).

It will be noted that the expectation of life at birth is lower than that for the immediately succeeding years. This is, of course, due to the excess mortality in the first year of life. Although the values of the expectation of life are of interest to public health authorities

ENGLAND AND WALES: DEATHS FROM PRINCIPAL CAUSES, 1939.

Causes of death.	All ages.		15–65.	
	Number of deaths.	Proportion per 1,000.	Number of deaths.	Proportion per 1,000.
1. Measles	309	1	5	0
2. Whooping cough	1,273	3	6	0
3. Diphtheria	2,171	4	153	1
4. Influenza	9,033	18	3,838	21
5. Tuberculosis of respiratory system	22,179	44	20,343	111
6. Other forms of tuberculosis	4,071	8	2,119	12
7. Cancer — malignant disease	68,981	138	32,660	179
8. Diseases of nervous system and sense organs	41,101	82	14,907	81
9. Diseases of the heart	139,232	279	37,744	206
10. Other diseases of circulatory system	32,041	64	7,005	38
11. Bronchitis	15,463	31	4,036	22
12. Pneumonia (all forms)	22,207	45	7,873	43
13. Other diseases of respiratory system	4,289	9	2,155	12
14. Diarrhœa and enteritis	4,172	8	741	4
15. Other diseases of digestive system	18,858	38	10,277	56
16. Non-venereal diseases of genito-urinary system	21,346	43	8,578	47
17. Premature birth and diseases of early infancy	14,174	28	—	—
18. Old age	17,328	35	107	1
19. Violence (all forms, including injuries and accidents)	24,509	49	13,999	77
20. Other causes	36,231	73	16,419	90
Total	498,968	1,000	182,965	1,000

	Proportion per 1,000 deaths.
(1) Diseases of the heart and circulatory system	255
(2) Cancer—malignant disease	179
(3) All forms of tuberculosis	123
(4) Diseases of the nervous system	81
(5) Bronchitis, pneumonia and other respiratory diseases	77

inasmuch as they record the improvement in the health of the community, primarily they serve the purpose of providing information necessary for the budgeting of such schemes as pensions.

To illustrate the progress made in extending the life of the community, the statistics of some past and recent life tables are compared. In Table B. the number of male and female survivors are stated for different epochs. According to the rates of mortality prevailing in the period 1871–80, out of every 100,000 male and 100,000 female children born the number who would reach age sixty-five was 29,716 males and 35,617 females; on the basis of the mortality in the period 1930–32, the number of male survivors at age sixty-five would be 54,899, and females 63,046.

Another method of recording the improvement is in terms of the average expectation of life (Table C.). If the rates of mortality which existed during 1871–80 remained unchanged, a male child born during that period had a likelihood of living 41·35 years, and a female 44·62 years. According to the most recent experience, 1930–32, the corresponding expectations are 58·74 years and 62·88 years. Much of this increase in the expectation of life is due undoubtedly to the large decline in infant mortality. At age forty-five the expectation of life in 1871–80 was 22·07 for males and 24·06 for females. In 1930–32 males and females of this age had a likelihood of an additional 25·51 and 28·30 years respectively. Or in the course of sixty years the expectation of life of males aged forty-five years increased 3·44 years, and of females 4·24 years.

The birth rate, death rate and infant mortality rate for 1942 were, respectively, 15·8, 11·6 and 49.

Students are advised to read "Principles of Medical Statistics," A. Bradford Hill (The Lancet Ltd., 3rd edition, 1943). Workers in tropical countries should consult "Vital Records in the Tropics," P. G. Edge (George Routledge & Sons Ltd., 1932).

In January, 1941, it was decided to start the compilation of an official medical history of the present war and later it was found that the classifications of medical statistics used for the history of the war of 1914–18 were not altogether suited to present conditions. "A Provisional Classification of Diseases and Injuries for use in compiling Morbidity Statistics" has recently been issued by the Medical Research Council (M.R.C. Special Report No. 248, 1944). This is comparable with the International List of Causes of Death, with the Diagnosis Code of the United States Public Health Service, and with the Diagnosis Codes of the Royal Navy, Army and Royal Air Force Medical Services. It is expected that the revised and amplified classification will require considerable modification, but, if its use proves satisfactory, it is hoped that the classification may be adopted for purposes of national records of morbidity in the post-war hospital services.

SECTION II

PREVENTION AND CONTROL OF DISEASE, OCCUPATION AND HEALTH, NOTES ON ANIMAL PARASITES, HOSPITALS, DISINFECTION

THE PREVENTION AND CONTROL OF DISEASE

EPIDEMIOLOGY may be defined as "the science of the mass phenomena of infectious diseases," or as "the natural history of infectious diseases."

Seasonal epidemics occur regularly at a given season from year to year, and this feature is known usually as seasonal prevalence. Some diseases, such as scarlet fever, show a variation in prevalence spread over many years, and this is usually referred to as secular variation. The severity as well as the extent of epidemics also varies from time to time.

The rise of an epidemic is probably due to one or more of the following factors: (1) an increase in the infecting power of the causal organisms; (2) an increase in susceptibility or a decrease in the power of resistance of the population concerned; (3) some alteration in the environment acting either on the infectivity of the causal organisms or on the resisting power of the population, *e.g.* extreme changes in the weather, massing together of large numbers of susceptible people, etc.

The decline of an epidemic, on the other hand, is probably due to one or more of the following: (1) an exhaustion of susceptible persons; (2) a decline in the infectivity of the causal organisms; (3) a decrease in the susceptibility or an increase in the power of resistance of the population; (4) an alteration in environment unfavourable to the infectivity of the causal organisms or favourable to the resisting power of the population.

Human intervention may play a part in cutting short an epidemic, *e.g.* vaccination of contacts and others in an outbreak of smallpox, measures taken to treat a contaminated water supply or to deal with an infected milk supply in the case of typhoid fever.

The cause of the periodic recurrence of epidemics has been a matter for much speculation, and the following are some of the explanations advanced: (1) changes in environment, especially in weather conditions; (2) the gradual accumulation of large

Deaths and Death Rates from Principal Infectious Diseases.

The deaths and death rates from the principal infectious diseases, in recent years and in earlier decennial periods, are shown in the following table:—

Name of Disease.	1871–80 average.		1881–90 average.		1891–1900 average.		1901–10 average.		1911–20 average.		1921–30 average.		1933.		1937.		1939.		1942.	
	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.	Number of Deaths.	Death Rate per 1,000 Population.
Cerebro-spinal Fever	—	—	32	0·00	18	0·00	100	0·00	715	0·019	417	0·011	942	0·023	698	0·017	501	0·012	1,206	0·029
*Diarrhœa and Enteritis	—	—	—	—	—	—	—	—	18,401	0·512	8,218	0·211	5,616	0·139	4,925	0·120	4,172	0·101	4,927	0·119
Diphtheria	2,943	0·12	4,473	0·16	8,067	0·26	6,092	0·18	5,058	0·141	3,270	0·084	2,646	0·066	2,963	0·072	2,171	0·053	1,826	0·044
Enteric Fever	7,842	0·32	5,401	0·20	5,340	0·17	3,097	0·09	1,278	0·035	428	0·011	222	0·006	206	0·005	113	0·003	89	0·002
Influenza	263	0·01	534	0·02	11,051	0·36	7,318	0·21	21,641	0·590	14,372	0·369	22,890	0·567	18,635	0·454	9,033	0·219	3,401	0·082
Measles	9,195	0·38	12,107	0·44	12,684	0·41	10,548	0·31	9,868	0·275	4,241	0·109	1,937	0·048	1,051	0·026	309	0·007	458	0·011
Poliomyelitis, Polio-encephalitis (acute) †	—	—	—	—	—	—	—	—	—	—	162	0·004	202	0·005	152	0·004	142	0·003	134	0·003
Puerperal Fever	1,794	0·07	2,308	0·08	2,081	0·07	1,634	0·05	1,184	0·033	1,108	0·028	1,061	0·026	596	0·015	476	0·012	283	0·007
Scarlet Fever	17,423	0·72	9,177	0·34	4,829	0·16	3,608	0·11	1,706	0·047	885	0·023	729	0·018	349	0·009	216	0·005	103	0·003
Smallpox	5,742	0·24	1,228	0·05	406	0·01	429	0·01	14	0·000	25	0·001	2	0·000	—	—	—	—	—	—
Tuberculosis (Respiratory System)	51,510	2·13	47,397	1·73	42,622	1·39	39,688	1·16	38,775	1·078	31,641	0·813	27,854	0·690	23,970	0·548	22,179	0·538	20,987	0·506
Tuberculosis (other than Respiratory System)	18,248	0·75	19,200	0·70	19,041	0·63	16,828	0·50	12,621	0·351	7,738	0·199	5,405	0·134	4,559	0·111	4,071	0·099	4,560	0·110
Typhus	1,398	0·06	392	0·01	76	0·00	31	0·00	5	0·000	1	0·000	—	—	—	—	—	—	—	—
Whooping Cough	12,453	0·51	12,360	0·45	11,561	0·38	9,455	0·28	6,538	0·183	4,429	0·114	2,270	0·056	1,750	0·043	1,273	0·031	799	0·019

* Comparable figures for the decennia prior to 1911–20 are not available.

† Figures prior to 1921 not available.

Note. In the case of some of these diseases the figures for recent years are not strictly comparable with those for the preceding decades owing to changes in nomenclature and classification due to increased knowledge of the disease and improved diagnosis. For the years 1915–20 the death rates, but not the numbers of deaths, relate to civilians only.

numbers of susceptible persons; (3) the introduction at intervals from outside of a fresh infection; (4) variations in the infectivity of the causal organisms; (5) changes in the immunity of the individuals composing the population.

The work of Topley and Greenwood on experimental epidemiology in mice is of great interest. The infections studied: mouse typhoid, mouse pasteurellosis and a virus disease (ectromelia) bear close analogies to certain intestinal, respiratory and virus infections in man; and some of the results obtained have a direct bearing on problems of human epidemiology. (The reader is advised to study "Some Notable Epidemics," Scott, H. H., Edward Arnold and Co., 1934; "Epidemics and Crowd Diseases. An Introduction to the Study of Epidemiology," Greenwood, M., Williams and Norgate Ltd., 1935; M.R.C. Report No. 209, 1936, "Experimental Epidemiology," Greenwood, Hill, Topley and Wilson.)

In the control of infectious disease it should be remembered that each case implies—(1) a source of infection, (2) a route of transmission, and (3) a susceptible recipient. The first essential is prompt and accurate diagnosis, and, in this connection, reliance should be placed in the first instance on clinical findings, though full use should be made of the laboratory to confirm or disprove such findings. The folly still persists of waiting for the results of a bacteriological examination before administering antitoxin to a patient showing signs of diphtheria. Inquiry should then be directed towards discovery of the source of infection. The movements of the patient should be ascertained at the time when he might be expected to have become infected, and a search should be made for a human source of direct infection, such as a previous case, a missed case or a carrier; or for a source of indirect infection such as infected food or water or, in suitable cases, an animal vector. The inquiry should include an investigation into social conditions, such as housing, work, recreation.

1. *Source of infection.* Isolation of infected individuals should be prompt and effective, and disinfection, especially current, should be practised. Those in attendance on the patient should if possible be immune to the disease. When isolation is practised in the home of the sick person it is necessary to give the attendant detailed instructions with regard to prevention of spread of the disease. The problem of dealing with apparently healthy carriers of infective organisms is more difficult, and legal powers are given only in the case of typhoid or dysentery carriers employed in the handling of foodstuffs.

2. *Route of transmission.* Direct contacts must be ascertained and, in the case of children, usually excluded from school for a period rather longer than the incubation period of the disease in question. Smallpox contacts should of course be

vaccinated. Contacts of a case of diphtheria may be submitted to bacteriological examination. Different diseases demand different procedures. When the disease is air-borne the importance of spacing out beds in wards or dormitories must not be forgotten. The concentration of infection decreases directly as the cube of the distance from the source of infection. Screens may be placed between beds, beds may be turned alternately head and foot to the wall, and special attention should be paid to ventilation. Droplet infection may be conveyed by coughing, sneezing or even loud talking over a distance as great as from 20 to 30 feet in the case of finer droplets. The question of indirect infection through the agency of food and drink must be investigated in appropriate cases. Here carriers may play a part, and the importance of personal cleanliness and the possibility of the conveyance of infection by utensils or by flies must be borne in mind. Animal vectors have assumed an increased importance.

3. *The susceptible recipient.* It is probable that the powers of resisting infection may be increased by improving conditions of living and working and by the practice of personal hygiene. Specific resistance to disease may be obtained by active immunisation in the case of smallpox, diphtheria, scarlet fever, typhoid fever and other infections. Special measures may be adopted in particular diseases, such as the use of mosquito nets, etc., in malarial districts.

Diphtheria is a disease mainly of temperate climates. In England and Wales it has of late years become chiefly an urban disease, though during 1855–80 its recorded mortality was greatest in the less-populated areas. In 1942 notifications of diphtheria numbered 41,404 in England and Wales and fatal cases 1,826—a fatality rate of 4·4 per cent. The death rate per million living at ages under fifteen was 896 in 1891–95, 668 in 1901–05, 444 in 1911–15, 309 in 1921–25, 300 in 1931–35, and 192 in 1942 (the lowest ever recorded for this group).

The causal agent is *C. diphtheriæ*, of which three types can be distinguished culturally and by fermentation reactions. The *mitis* type is associated with diphtheria of low mortality, whereas the *intermediate* and *gravis* types appear to cause, as a rule, much more severe infections. The incubation period is from two to ten days, usually two to four. Children under thirteen suffer most, and the mortality is greatest at three or four years. After thirteen years the mortality declines. This incidence at school age was first noticed when the Elementary Education Act came into force in 1871. During school holidays the prevalence is less. Females show a higher mortality than males. Seasonal prevalence is most marked in the last quarter of the year and is lowest in the middle third. The case mortality of all notified cases in the L.C.C. area was 3·8 per

cent. in 1933. In pre-antitoxin days case mortality amounted to 30 per cent. The earlier antitoxin is given in the disease, the less likely is diphtheria to prove fatal. In cases treated on the first day the mortality has been shown to be practically *nil*, on the second day 3·08 per cent., on the third day 6·1 per cent., on the fourth day 10·6 per cent., and on the fifth and subsequent days 11·5 per cent. In addition early injection of antitoxin tends to diminish the frequency and severity of subsequent paralysis.

Diphtheria is not highly infectious, and fairly close contact is usually necessary for the spread of the disease. The bacilli can be isolated in large numbers and in virulent condition from floor dust in the neighbourhood of diphtheria patients and may remain fully virulent in such dust for at least fourteen weeks *in vitro* and five weeks on the floor. Disturbance of such dust allows the bacilli to rise into the air. Treatment of the floors with spindle oil reduces, and may entirely eliminate, air contamination from this source (*Lancet*, 2nd August, 1941, p. 123, Thomas, J. C.; see also p. 224). In schools the common use of pens, pencils and slates by the scholars may be responsible for outbreaks. Missed cases and those carrying the organism in their throats, noses, or ear discharges are the common centres of infection. Infective nasal discharges are specially apt to be missed, and many outbreaks in school classes have been traced to such an origin. Return cases are, however, much less numerous than in scarlet fever (see p. 49). The results of an investigation by Glass and Wright indicate that cross-infection in diphtheria wards is not uncommon. To the patient admitted in error to such a ward it offers certain dangers and this provides an argument for the reception of dubious cases into special observation wards. In a series of 246 patients cross-infection occurred in 36·6 per cent., and in patients who were in hospital for more than two months it occurred in 68 per cent. The authors point out that cases within their knowledge had been detained in hospital from 120 to 160 days on account of cross-infection at an average cost of £50 per head (*J. Hygiene*, 1938, Vol. 38, pp. 248–54). Considerable numbers of children carry in their throats organisms indistinguishable from diphtheria bacilli—as many as 10 per cent. during epidemic periods. All these organisms are not virulent on injection into guinea-pigs, and the recognition of the non-virulent cases, which otherwise are often isolated, is of primary importance. Carriers of virulent bacilli almost invariably show a negative reaction to the Schick test.

The Schick test is used to detect people who are susceptible to diphtheria and need immunisation and to confirm immunity after immunisation. The intradermal injection of a definite amount of diphtheria toxin known as the Schick dose is given.

A local reaction occurs in persons with less than a certain amount of circulating antitoxin which, while neutralising the toxin, does not affect other substances which may be present and which give rise to pseudo reactions in certain sensitive people. It is, therefore, necessary to use a control fluid in which the toxin, but not the non-specific constituents, has been destroyed by heat. (As children under ten years of age seldom react to these non-specific substances, it is probably unnecessary to use the control fluid in this age group.)

Into the left forearm anterior surface 0·2 c.c. of the toxin is injected intradermally and into the right forearm 0·2 c.c. of the control fluid is injected. Two 1 c.c. syringes divided into tenths are used, one for the toxin dilution and the other for the control. The needles must be short and stout with short bevels. The reactions may be read at 24–48 hours, though 5–7 day readings are essential to detect late reactors and to reconsider earlier doubtful readings. By comparing the lesions on the two arms one can decide whether the reaction is due to the active toxin and how far to non-specific constituents. In a *negative* reaction (immune) nothing is visible on either arm, while in a *positive* reaction (susceptible) the left arm shows a flush some 10 to 50 mm. in diameter which fades and becomes brown. In the *pseudo* reaction both arms show a similar flush. All doubtful reactions should be regarded as positive, except pronounced pseudo reactions which invariably indicate immunity. Although the diluted toxin contains antiseptic, the whole contents of the bottle should be used at the one session if possible or within a short time.

Milk has been considered the medium of infection in certain cases (L.G.B. Report, New Series, No. 94, 1914), but diphtheria is not a disease from which the cow can suffer. The popular idea that lower animals, such as pigeons and other birds, cats and horses, suffer from diphtheria has little scientific evidence to support it. Post-scarlatinal diphtheria is well recognised, and is probably due to the introduction of a diphtheria carrier into a scarlet fever ward.

Notification should be limited to persons exhibiting clinical signs of the disease, with or without bacteriological evidence of the presence of diphtheria bacilli. Healthy carriers, if notified and removed to hospital, may be the cause of exclusion from hospital of others urgently requiring treatment. Tests for virulence of the bacilli in such carriers should be made either by subcutaneous or by intradermic injections into guinea-pigs. Non-virulent diphtheria bacilli are not known to be capable of changing into virulent organisms. As genuine cases of diphtheria require skilled nursing and treatment, their removal to isolation hospitals is advisable. Anti-toxin should be given as early as possible in the disease in doses

of 8,000 units in mild cases, 15,000 to 30,000 units (intramuscular or intravenous) in moderately severe cases and 50,000 to 100,000 units (intravenous) in severe cases. Intravenous injections of 50 per cent. glucose should be given in addition in severe cases. If more than 20,000 units are necessary, the intravenous route should be chosen. It is rarely necessary to exceed 100,000 units. A single dose of antitoxin is more efficacious than the same amount in divided doses. When rapid absorption of antitoxin is imperative and the intravenous route is impracticable, a possible, but inferior, substitute is intraperitoneal administration (L.C.C. Report, "The Dosage of Antitoxin in Diphtheria, 1936"). Many unsatisfactory results in the treatment of cases are due to the medical attendant having waited for a bacteriological report on swabs before administering antitoxin. (*Proc. Roy. Soc. Med.*, Vol. XXIX., No. 2, March, 1936, pp. 481–496, "Discussion on the use and abuse of the swab in combating diphtheria.") Antitoxin should be kept by local authorities, to be issued, if necessary, free to medical practitioners. With regard to routine swabbing of patients, "it may be advised that when the bacteriological resources at the disposal of the hospital are limited, they will best be utilised for purposes of diagnosis of doubtful cases, and, with regard to convalescents, for those showing chronic nasal discharge or chronic sore throat, the nature of which requires special investigation from the carrier point of view. In such instances it is always desirable that the laboratory should be in a position to follow up any positive results by virulence tests." A modification of the prepared Solé swab makes it possible to obtain a morphological diagnosis of the organisms in a few hours when necessary. The use of blood tellurite-agar medium in experienced hands will give more positive results than Löffler's medium, and the more severe cases are less likely to be missed. The removal of enlarged tonsils, adenoids, etc., has been shown to reduce the number of infective carrier cases after diphtheria (*Med. Off.*, 12th August, 1933, p. 67). Antiseptic snuff containing sulphathiazole and sulphapyridine may be tried in the case of nasal carriers. Discharged cases should not mix with other children for at least two weeks after returning to their homes. There is little risk in a convalescent's returning to school if his throat is normal and he is free from nasal discharge.

Diphtheria is still the most common single cause of death among children of school age in this country in spite of efforts to control the spread of the infection by compulsory notification, hospital isolation, disinfection of rooms, clothes, bedding, etc. Radical changes in attempts to lower the incidence have, however, taken place in recent years as a result of the introduction of means for artificial immunisation against the disease

which, if carried out with proper precautions, involves no risk whatever either to the individual or to the community. Experience in the United States of America and in Canada has shown that if three-quarters of the number of children at each year below fifteen were immune and this level maintained year by year the disease would practically disappear. It is not sufficient that only children of school age should be immunised. The immunity produced is antitoxic and not bactericidal and immunised children might become healthy carriers and endanger the non-immunised. In Memo. 170/Med., 1932 (revised in 1940 and 1942), the Ministry of Health advised local authorities to offer facilities for the immunisation of all children over the age of one year, and in 1940 undertook to provide the authorities with an approved prophylactic free of cost.

Various forms of diphtheria prophylactic are available for use in different circumstances but all must satisfy the requirements of the Therapeutic Substances Regulations as regards immunising potency, sterility and freedom from toxicity. The principal prophylactics are :—

A.P.T. (*Alum Precipitated Toxoid*).
T.A.F. (*Toxoid-Antitoxin Floccules*).
T.A.M. (*Toxoid-Antitoxin Mixture*).
F.T. (*Formol-Toxoid*).

The technique for the use of all these prophylactics is the same. The injection is best made intramuscularly into the arm above the insertion of the deltoid.

With all these prophylactics 80–100 per cent. will be found Schick negative within three months of the final injection. Diphtheria, almost invariably mild, may sometimes occur among Schick-negative reactors and parents should be warned that, notwithstanding immunisation, children suffering from a sore throat should be seen by a doctor.

Most city children inherit immunity from their mothers and do not require immunisation within the first few months of life, but between nine months and eight years old they are mostly non-immune and rarely suffer from reactions after immunisation. Up to eight or ten years the Schick test may be omitted and all these children immunised, but older children should be Schick tested in the first instance.

The choice of prophylactic depends on the amount of testing and supervision practicable, the fear of reaction, and the rapidity with which immunity is required. The best results are obtained when some weeks (about four) elapse between the doses. When three doses are given the interval between the second and third injections need not be longer than two weeks.

A.P.T. (*Alum Precipitated Toxoid*). The immunising effi-

ciency of this prophylactic depends on the deposition of the relatively insoluble aluminium-toxoid compound at the site of the injection and its gradual liberation. There may be a small amount of local reaction and this may be an essential factor in the immunisation which results, and a small painless nodule may form which gradually disappears. Undue sensitiveness to immunisation may be detected from the response to the injection of the Schick control fluid as patients who give a clear pseudo reaction one or two days after the Schick test will suffer less reaction with T.A.F. than with A.P.T. In this country and in the United States of America the present practice is to use two doses of 0·2 c.c. and 0·5 c.c. respectively of A.P.T. particularly for young people, while for adults, three doses each of 1 c.c. of T.A.F. are commonly employed.

In the ordinary routine of immunisation of children probably A.P.T. will be the prophylactic preferred. For children under eight years of age a first dose of 0·2 c.c. (10 Lf. units) may be used though some prefer 0·5 c.c. (25 Lf. units). Such doses very rarely cause troublesome reactions. The second dose of 0·5 c.c. is given four weeks later. For older children and adults a first dose of 0·2 c.c. has been frequently used. This detects an unusually sensitive person who may show some local reaction.* In such cases the further immunisation may be a second dose of 0·2 c.c. of A.P.T. or two further doses of 1 c.c. of T.A.F. at intervals of three to four weeks. If there is no reaction after the first injection the second dose of 0·5 c.c. may be given four weeks later.

T.A.F. (*Toxoid-Antitoxin Floccules*)—a suspension of the precipitate of floccules formed when toxoid and antitoxin are mixed. This is the least likely of all prophylactics to cause reaction and is, therefore, much used for the immunisation of adults.

T.A.M. (*Toxoid-Antitoxin Mixture*). The toxoid is diluted and partially neutralised by antitoxin. This is a less efficient prophylactic and is less used than formerly.

F.T. (*Formol-Toxoid*). This is diphtheria toxin detoxicated by the action of formalin heat from which the other three prophylactics are prepared. It has a high immunising efficiency but may cause severe reactions in older people.

In France and Canada F.T. is used almost exclusively, but has been largely replaced in this country by A.P.T. for children and T.A.F. for adults.

* This procedure dispenses with the necessity for employing the Moloney test for hypersensitiveness. The Moloney test consists of the intradermal injection of 0·1 c.c. of 1–100 diluted formol toxoid. A positive reaction (redness, induration) within twenty-four to forty-eight hours indicates special susceptibility and the necessity for reduced dosage or the employment of T.A.F. instead of F.T. or A.P.T.

Medical Officers of Health should urge the immunisation not only of children between the ages of five and fifteen years but also of infants approaching the age of one year. Children who receive a course of injections thus early should be given a "boosting" dose of 0·5 c.c. A.P.T. on beginning school life and again at the age of eight to nine years.

There is much to be said for the practice of giving all Schick negative nurses and other persons who may be exposed to a high risk of infection a single stimulating dose of 0·5 to 1·0 c.c. of T.A.F.

In all cases the Schick test should be done not less than three months after the last injection. It will usually be found that a few of those who have been given the ordinary course, the number varying from 1 to 10 or 15 per cent., are still susceptible. Such cases should be subjected to a second similar course and again tested not less than four weeks later.

Prior to the war legislation had made compulsory in France the immunisation of all children aged two to three years; in Poland of children aged one to ten years; in Italy of children aged two to ten years; and in Hungary the immunisation of all children aged two years, and their re-immunisation at six years. In Guernsey the compulsory immunisation of children aged two to ten years was introduced in 1939 (*Public Health*, December, 1939, p. 59, Revell, R. W.).

In New York immunisation against diphtheria has been practised for about twenty years. An intensive campaign began in 1929, and by the middle of 1935, 1,110,000 children under the age of fifteen years had been immunised in addition to those protected in previous years. This figure included some 65 to 70 per cent. of children under the age of six years, and it is noteworthy that the incidence of diphtheria in 1938 was only about one-tenth of what it was in 1929. During the same period the death rate from diphtheria in the age period one to fifteen years fell from 27·4 to 2·1 per 100,000, and the total death rate fell from 6·8 in 1929 to 1·1 per 100,000 in 1940.

Past experience has shown that the disease had a six years' periodicity in New York and a four years' cycle in Toronto and, in view of this, epidemics should have occurred in both cities between 1930 and 1940, but none has been recorded.

In Toronto (population over 600,000), where immunisation of pre-school and school children has been extensively carried out since 1925, up to the end of 1937 there had been only one death from diphtheria since 1925 in the immunised group. Toronto's impressive diphtheria record shows a reduction from 1,022 cases and 64 deaths in 1929 to 7 cases with but one death in 1939. During 1940 there were no cases, in 1941 there were 20 cases with 2 deaths, and in 1942 58 cases with 7 deaths.

It is estimated that by the end of 1942 approximately

1,150,000 children under five and 2,598,000 children between the ages of five and fifteen had been immunised in England and Wales under local authorities' arrangements. This represents about half the child population. The average immunisation rate per 1,000 of the child population in the county boroughs, calculated from the figures for 1940 and 1941, was about 205 and varied from as low as 47 to as high as 509 per 1,000. The usual practice is for immunisation to be offered in maternity and child welfare clinics and through the agency of the school medical service. General pactitioners also undertake this work and are paid a fee by the local authority for each child immunised. In the City of Portsmouth the work of a mobile unit has been very successful.

(" The Principles and Practice of Diphtheria Immunization," J. Tudor Lewis, Oxford University Press, 1941; M.R.C. Special Report, No. 247, 1943, Russell, W.T.).

Scarlet fever is due to a local infection of the throat by certain strains of *Streptococcus hœmolyticus*, which produce a soluble toxin causing the general manifestations of the disease. Less toxigenic strains may be equally capable of epidemic spread producing most of the symptoms and sequelæ of scarlet fever but no rash except in a small minority of the infected persons. Serological " groups " and " types " of the hæmolytic streptococcus can be distinguished, of which Group A comprises the great majority of human infections. Within Group A there are some 30 types all of which can produce disease in epidemic form; the types " breed true " so that type identification can be used to delimit the extent, and sometimes to detect the source, of such outbreaks, whether predominantly scarlatinal or not. Scarlet fever is a disease of temperate climates and is more prevalent in towns, especially industrial centres, than in rural areas. The incubation period varies from one to eight days, but is usually two to three; the rash appears on the first day: contacts should be excluded from school for two weeks. The greatest attack rate is between the fourth and sixth years, but the case mortality is highest in the first and second years. The disease is, however, rare in infants under twelve months. Many persons never contract the disease, and if a child can be protected in its early years it will be less susceptible to attack later on, and less likely to die should it become infected. Females are more liable to attack, but more fatal cases occur among males. The patient is infectious from the very beginning of the symptoms, but most cases, in the absence of morbid discharges from the nose or ears, cease to be infectious about the fourth week. Desquamation is probably harmless in itself unless the scales have been contaminated by any of the discharges. In the Ministry of Health Report, No. 35, 1927, the conclusion is reached that " there is

no good reason for prescribing a routine period of detention in hospital of more than four weeks in uncomplicated cases." The disease is spread usually by direct contact with an individual in the acute stage or suffering from a chronic discharge of the nose or ears. Missed cases of a mild type of the disease are often responsible for infecting other persons. Epidemics have been traced to milk supply into which infection has most likely been introduced by a human carrier (see p. 358). The case mortality at present is less than 1 per cent. The disease has assumed a milder form, but the prevalence is not diminishing to the same extent as the mortality.

"Relapses" are of considerable administrative importance and amount on an average to from 1 to 2 per cent. The cubicle system of isolation is now available in all modern infectious disease hospitals, and in cases of streptococcal infection prompt isolation in this way will often prevent relapses due to infection with another strain of hæmolytic streptococcus (*Lancet*, 7th May, 1938, p. 1068, "Streptococcal Infections," Allison.)

Return cases have been defined by the Society of Medical Officers of Health as "cases occurring in the same house or elsewhere, and apparently traceable to the person released within a period of not less than twenty-four hours, or not more than twenty-eight days, after his return or release from isolation." Though occasionally such infections occur in cases of diphtheria, the disease with which they are most commonly associated is scarlet fever. The report of the M.O.H. for Manchester for 1936 contains particulars of that year's return cases in his area. The number of patients discharged from the Manchester isolation hospitals after treatment for scarlet fever was 2,114, and the number of true return cases was 71, a return case rate of 3·4 per cent. The average period of stay in hospital of the primary case was thirty-four days. The average interval elapsing between the discharge of the primary case and the onset of the disease in the secondary case was 11·1 days, 32·4 per cent. of the return cases being infected during the first week after discharge of the primary case, 38 per cent. in the second, 19·7 in the third, and 9·9 in the fourth. In 14 patients a condition was noted after discharge to which infection might have been attributed: rhinorrhœa, 6 cases; excoriation of the nose, 5; mastoiditis, 1; sore lip, 1; and catarrhal cold, 1 case. The other infecting cases remained free from discharges and other complications at the time of the occurrence of the secondary case. Fifty-three infecting cases gave rise to 1 return case each, 7 to 2 each, and 1 to 4, so that the 71 return cases originated from 61 discharged patients, a percentage of 2·9 of those discharged from hospital. The age group of the discharged patients from whom came the highest proportion of cases was 5–9 years, in which the percentage was 3·8. The

1–4 age group was the next most common with a percentage of 3·3, while of patients aged 20 years or over only 0·6 per cent. gave rise to return cases. (*B.M.J. Supplement*, 20th August, 1938, p. 155.) Return cases are most numerous when fever hospitals are full, particularly during epidemics, and may be attributed either to a greater tendency of the disease to spread or to overcrowding in the hospitals with resulting relaxation of the regulations (Ministry of Health Report, No. 16, 1923). It is possible that the incidence may be lowered by more stringent isolation of the severe cases of scarlet fever and segregation of patients under fresh-air conditions for the last two weeks of convalescence. Thorough cleansing of the patient must be practised before discharge from hospital. As a general rule chronic carriers are rare in scarlet fever, though some interesting cases are quoted in Parson's Report (Ministry of Health, No. 35, 1927, pp. 252–257).

In the *Journal of Hygiene*, May, 1935, pp. 283–299, Brown and Allison give an interesting study of 808 patients discharged from hospital convalescent from scarlet fever. The carrier rate of hæmolytic streptococci was 82·8 per cent., the infecting case rate 3·7 per cent., and the return case rate 4·9 per cent. Their conclusions were as follows :—

1. In view of the high carrier rate on discharge from hospital, the bacteriological examination of swabs from scarlet fever patients is of no value in the detection of probable infecting cases.

2. There is, however, a definite relationship between the degree of infection, as measured by the profusion of hæmolytic streptococci in cultures on discharge, and the likelihood of the patient infecting others.

3. The causal connection between infecting case and return case is strongly supported by finding the same serological type of *Streptococcus pyogenes* in both cases.

4. A patient who has had complications in hospital is slightly more liable to become an infecting case than one whose course has been uncomplicated.

5. The commonest age group of infecting cases is 5–10 years.

6. The majority (70 per cent.) of the return cases occurred within fourteen days of the arrival home of the infecting case.

7. Overcrowding in the home and the number of the susceptibles exposed do not appear to be important factors in the production of return cases.

8. A history of tonsillectomy does not appear to bear any important relationship to the occurrence of infecting cases, but the inconclusive nature of the findings indicates the desirability of further investigation of this question and that of the relation of the condition of the tonsils to their infectivity.

9. Discharge from hospital as early as is consistent with a satisfactory clinical condition is shown to be advantageous

from the point of view both of the patient and of the hospital administration.

10. The administration of scarlatinal antitoxin is likely to render a patient less liable to convey infection on discharge.

It is doubtful, in view of the present mild type of the disease, if the removal to hospital of all cases is worth the expense or is advisable on public health grounds. Many cases are unrecognised, and the isolation of others is thus rendered less useful. In addition, before removal is carried out, the patients have usually been ill for some little time. It is especially inadvisable during times of epidemic prevalence, when hospitals may become so overcrowded as to be actually dangerous to the health of the inmates. Evidence is accumulating that the scarlet fever ward, by providing opportunities for cross-infection with other "types" of hæmolytic streptococci, may increase the number of secondary complications (otitis media, rhinitis, etc.) and prolong the period of infectivity with correspondingly greater numbers of "return cases." In no case should beds be reserved for scarlet fever cases to the exclusion of more serious diseases, such as diphtheria or enteric fever. On the other hand, severe and complicated cases require hospital treatment, inasmuch as proper nursing is likely to improve their chances of recovery, and as they themselves are more likely to spread infection. Again, cases should not be left at home where their remaining might cause public alarm, as in post offices, laundries, dairies, etc., or where pecuniary loss might be incurred, as in hotels or boarding-houses, more particularly in health resorts. Local circumstances must determine the amount of hospital accommodation to be provided. (*Lancet*, 20th June, 1936, p. 1438, "Isolation of Scarlet Fever in the Home," Duncan Forbes.)

Work done on the hæmolytic streptococci has shown that the scarlet fever streptococcus produces a soluble toxin which is responsible for the toxæmia, nausea and rash and that recovery from the disease depends on the production of antitoxin. As a result of all this work we have now at our disposal a skin test for susceptibility, a means of producing active immunisation against scarlet fever, a diagnostic test and a method of treatment by scarlet fever antitoxin. It should be remembered that laboratory animals are insusceptible to the toxin and that in consequence standardisation of the toxin has had to be done on human beings. In America a standard unit known as a skin test dose has been adopted.

Susceptibility or Dick test. Intradermal injection of 0·2 c.c. of 1 in 1,000 dilution of scarlet fever toxin will produce in twelve hours or less in susceptible persons an area of reddening of 1 cm. or more in diameter. The syringe as well as the needle should be rinsed out with skin test solution before use and

should be sterilised by dry heat, in an autoclave, or by boiling in distilled water. Alcohol and other disinfectants should be avoided as they may precipitate the toxin. A control injection of heated toxin may be given at the same time. A good deal of experience of this test has been obtained in the United States of America and there it has been found that new-born infants usually show negative reactions which become positive later in the first year of life. Among older children in overcrowded institutions susceptibility may be as low as 10 per cent. and in rural areas as high as 85 per cent. The reversal of a positive Dick reaction in the early stage to a negative in convalescence during the course of the eruptive fever is confirmation of the diagnosis. The persistence of a positive reaction, however, does not exclude scarlet fever, and the commonest error of all is interpreting positive reactions as negative.

Active immunisation. A series of four or five weekly subcutaneous or intramuscular injections of scarlet fever toxin, which contains no blood or serum, is given representing 500 skin test doses and increasing to 80,000 or 100,000 skin test doses. The Dicks recommend superficial subcutaneous injections given " near enough the under surface of the skin to produce a visible subcutaneous lump." A susceptibility test should be performed two weeks after the last injection. Some 90 per cent. of persons so treated appear to retain their immunity for years. In this country such immunisation is restricted to persons specially exposed to risk, *e.g.* hospital staffs, but it is unsatisfactory and reactions are often as severe as the disease.

Scarlet fever antitoxin. Antitoxin is used largely in the treatment of scarlet fever both in this country and elsewhere. The United States unit of antitoxin is ten times the smallest amount of scarlet fever antitoxin necessary to neutralise one test dose of toxin, each test dose representing five skin test doses. The skin test dose is the amount of toxin necessary to produce in a majority of susceptible persons a reaction of at least 1 cm. in diameter about twenty-four hours after intracutaneous injection. For the purposes of treatment the serum may be administered either intramuscularly or intravenously. The usual intramuscular dose of serum is 10 c.c. for mild cases and 20–40 c.c. for severe cases. As a rule one dose of the serum is sufficient, but severe cases may require two or even more doses. In the opinion of medical superintendents of isolation hospitals the administration of serum tends to cut short the fever within twenty-four to thirty-six hours and to reduce markedly any toxæmia that may be present. The rash is reduced in intensity and duration, and there is some evidence that complications are less frequent in patients receiving serum than among those not so treated. It is difficult to estimate the

effect of this treatment on mortality from scarlet fever on account of the very mild type of the disease which has been prevalent in this country for some time. Banks has found it possible as a result of serum treatment to discharge his scarlet fever patients from hospital in about thirteen days. (*Public Health*, January, 1932, pp. 101–111, Banks).

Passive immunity may be produced by the intramuscular injection of antitoxin. The immunity, as assessed by a Dick test, lasts about a fortnight. Such immunisation may prove useful in the prevention of scarlet fever in susceptibles about to undergo nasopharyngeal operations, or in the event of a case of scarlet fever occurring in a diphtheria ward, or to prevent spread of the disease in a children's hospital. The administration of antitoxin to all positive reactors to the Dick test may prevent further spread of scarlet fever in the ward. All children in the ward should be Dick-tested as soon as possible, and the following day all Dick-positive children should be given 5 c.c. of scarlatinal antitoxic serum intramuscularly. On the third day positive children should be again Dick-tested, and, if found doubtful or positive, a further dose of serum should be given. Finally scarlet fever antitoxin may be used for the diagnosis of doubtful rashes—*Schultz-Charlton reaction* or the blanching test. In this test 0·2 c.c. of a 1 : 10 dilution of scarlet fever antitoxin is injected intradermally in an area where the rash is marked. If the rash is a manifestation of scarlet fever there will be blanching of the rash round the area of injection in from eighteen to twenty-four hours at the latest. This test is not of much practical value, as the best reactions are obtained in those cases which are easy to diagnose on clinical grounds. (*Bull. Hyg.*, July, 1934, pp. 431–440, Joe; *B.M.J.*, 28th December, 1935, p. 1249, "The Diagnosis of Doubtful Cases of Scarlet Fever," Brown and Allison; Report of the Committee on Immunization, including Vaccination, British Medical Association, 1935; *Public Health*, July, 1940, p. 221, "Paths of Spread of Acute Streptococcal Infections," Allison, V. D.; *Lancet*, 16th March, 1940, pp. 511–13, 23rd March, 1940, pp. 560–63, Gordon, J. E.).

Epidemic or **septic sore throat** is really a streptococcal tonsilitis due frequently to an infective milk supply. (See p. 358.)

Measles (morbilli) occurs both in temperate and in tropical countries. The causal agent is probably an ultra-microscopic virus; the incubation period is from seven to fourteen days (usually ten); the rash appears on the fourth day; isolation lasts for three weeks, or till all complications and discharges have ceased, and exclusion of infant contacts for twenty-one days. Epidemics occur usually every two years in towns, and last, as a rule, from the end of October to the end of the

following June, the height of the outbreak being reached during January and February. Brincker has shown that in London a measles epidemic does not arise in a community of children until the susceptibles rise to 25 per cent. and the epidemic does not stop until the susceptible population is reduced to under 20 per cent. The disease affects mainly children under seven years of age and is most infective during the pre-eruptive stage, from the ninth to the twelfth day of incubation. The chief cause of mortality in measles is secondary infection by hæmolytic streptococci with resulting broncho-pneumonia. The chief disabling complications are otitis media and ophthalmia. Children of pre-school age are the most susceptible to the disease and to its complications, and the greatest number of deaths occur in the second and third years of life. Stocks has pointed out that for every 100 children suffering from an attack of measles in a densely populated area about 300 others become temporarily immunised. Of these 300 some 250 lose their immunity before the next epidemic. It is the latter group, together with those born subsequent to the epidemic, who make up the vulnerable population ready to start the next outbreak. (*Lancet*, 11th January, 1936, pp. 103–107, "The Control of Measles," Brincker.)

In 1942 the number of deaths from measles in England and Wales was 458, and in 1937 the mortality of all cases treated in the L.C.C. hospitals was 1·53 per cent. As a rule in epidemics the case mortality lies between 1·4 and 4 per cent. Measles is the most fatal of all diseases in children under five years of age.

Notification of measles and of German measles was introduced in 1915 (Measles and German Measles Order), but was rescinded in 1919 on account of administrative difficulties. Notification is however now required by the local authority under the Measles and Whooping Cough Regulations, 1940. The practical value of notification depends on the extent of the measures available for preventing the spread of infection and for diminishing the mortality from the disease. Each case should be regarded as a means of discovering other cases. The domestic isolation and treatment, including the nursing of patients, need supervision, and provision should be made for the reception of selected cases in an isolation hospital.

About 75 per cent. of all London elementary school children have suffered from measles, and spread of the disease may be expected in any class containing over 30 per cent. of children not protected by a previous attack. If a sickness record is kept of all children attending elementary schools, it will be an easy matter during a measles epidemic to exclude all those who have not already had the disease (see p. 287). School closure for measles has not justified itself in the past, largely on account of

the multiple opportunities of infection, elsewhere than in schools, afforded in large towns. As most of the cases will have to be treated at home, the local authority can help by means of health visitors and nurses employed either directly or through a nursing association. The poorest families should be attended first, and especially those in which children from one to four years are suffering from measles or have been exposed to infection. Leaflets of advice regarding measles may be distributed to parents as an auxiliary to personal advice and assistance. (See L.G.B. Memo. on Measles, November, 1915; Reports of M.O.H. and S.M.O., London County Council, 1933 and 1936, on Measles Epidemics, 1931–32 and 1933–34; and *Proc. Roy. Soc. Med.*, Vol. XXXI., May, 1938, pp. 807–828, "A Historical, Epidemiological and Ætiological Study of Measles," Brincker.)

Convalescent and adult serum in prophylaxis of measles. The intramuscular injection of such serum is the most promising method of preventing or modifying an attack of measles. Between 200 c.c. and 300 c.c. of blood may be withdrawn between the seventh and fourteenth days after defervescence from a patient who has suffered from an attack of uncomplicated measles or alternatively from an adult who at some time or another has had measles. Sterility tests and Wassermann reactions should be done on each serum and 0·5 per cent. phenol added. Convalescent serum is twice as potent as pooled adult serum.

The results of the prophylactic use of such serum vary according to the time of administration. (1) Injected within three days of exposure, the serum usually confers protection lasting from two to four weeks. This method is useful for the very young and for those in ill-health, for those resident in hospital or exposed to other infections, or for pregnant women. (2) Injected on the third to the fifth day after exposure, a modified attack follows as a rule, and this gives permanent immunity. This method is preferable, it is applicable in the case of healthy children over two years of age, and is especially useful in general practice.

The dosage recommended is 5 c.c. of convalescent serum in the case of children under three years; for children of three and over the dose may be reckoned by multiplying the age in years by two. If adult serum is used these amounts should be doubled. A modified attack, with resulting economy of serum, may be produced by giving half the dose of serum recommended within the first five days following exposure. The serum loses potency amounting to 25–50 per cent. in one to two years. Drying the serum appears to prevent such loss. Sometimes whole blood obtained from a parent may be used, 30 c.c. being injected immediately it has been drawn off.

Schemes for the provision of serum have been adopted by

various local authorities, such as the London County Council, Birmingham and Newcastle.

An extract of the globulin fraction from human placentas has been shown to possess definite prophylactic properties. (*J. Roy. San. Inst.*, September, 1932, Burn, M. ; "Report of the Committee on Immunization including Vaccination," British Medical Association, 1935 ; *Lancet*, 2nd April, 1938, pp. 795–799, Gunn, W.)

Rubella (rose measles, German measles) is a mild disease made notifiable in 1915, as it is frequently confused with true measles and scarlet fever. The incubation period is five to twenty-one days ; the rash appears on the first day ; isolation is maintained for one week from the date of appearance of the rash, and contacts are not generally excluded from school. Notification ceased on 31st December, 1919, under the Rescission Order, 1919.

Mumps (infective parotitis) is apt to be more severe in adolescents and adults than in young children. The incubation period is from twelve to twenty-three days; isolation lasts until one week after subsidence of the swelling, and contacts are not, as a rule, excluded from school. It is most prevalent in spring and autumn. The causal agent is unknown.

Whooping-cough (pertussis) is a disease mainly of temperate climates. Epidemics occur at irregular intervals, and seasonal prevalence is greatest in March and April. It is notifiable under the Measles and Whooping Cough Regulations, 1940. The incubation period is from six to eighteen days ; isolation lasts for four weeks after the onset of coughing, and infant contacts should be excluded from school for three weeks from the date of onset of the last case or three weeks from the date of last exposure to infection. The disease is most infective during its early catarrhal stage, *i.e.* before any characteristic whoop has developed. A diagnosis may be made during this stage in some 80 per cent. of cases (and also in diminishing percentages as the weeks pass) by making the patient cough over a plate of special medium held about 4 inches in front of his mouth, and then examining the plate, after incubation, for *Hæm. pertussis*. In mild cases the whoop may never occur and even in severe cases it is often irregular and at a late stage in the disease. In 1942 there were 799 deaths from whooping-cough in England and Wales. Some 90 per cent. of the deaths occur under five years and about half in the first year. As in measles, most of the deaths are due to broncho-pneumonia directly attributable to lack of proper attention at home. The fact that infants under one year suffer so seriously, however, makes the question of hospital treatment particularly difficult.

Some measure of success has followed the prophylactic

vaccination of children with phase I vaccine made from smooth, freshly isolated, fully virulent strains of *H. pertussis.* Large doses of vaccine are given but a high degree of protection cannot yet be guaranteed. A combination of whooping-cough vaccine and diphtheria prophylactic is being tried by some workers.

Chickenpox (varicella) is of consequence mainly on account of its resemblance, in certain cases and particularly in adults, to smallpox. Hence in times of smallpox prevalence chickenpox is often made notifiable. The incubation period is eleven to twenty-one days—vesicles appear about the first day; isolation lasts till the skin is quite clear, and contacts are not excluded from school. Chickenpox patients may be infectious for four days before the appearance of the rash, on the day of its appearance and for four days afterwards. Isolation at the onset of the disease is therefore ineffective in preventing the occurrence of further cases. There is strong evidence in favour of the view that the viruses of varicella and herpes zoster are closely related and possibly identical (*Lancet*, 14th September, 1940, pp. 339–40, Evans, P., " An Epidemic of Chickenpox ").

Smallpox (variola). In recent years it has been found necessary to differentiate two types of smallpox—variola major and variola minor. Variola major is the type which prevailed in this country in the epidemics of 1871, 1892 and 1901–1902, and had a case mortality of 15–18 per cent. It is endemic nowadays in a number of tropical countries. Its incubation period is usually twelve days (ten to fourteen); the rash appears on the third day; isolation should last till all scabs have separated (usually three to four weeks). Seasonal prevalence is most marked in the first half of the year. Any age may suffer; males show a higher mortality than females; and case mortality is greatest in infancy and least between ten and fifteen years. The disease may be spread by droplet infection and by infected articles. In 1934 an outbreak in Blackburn was considered to be due to cotton imported from an infected area abroad. (See *Proc. Roy. Soc. Med.*, Vol. VIII., Pt. II., 1915, pp. 89–107, " Smallpox Among Cotton Operatives," Corbin.) It should be remembered that smallpox may be contracted from the body of a person who has died of this disease. Mild unrecognised cases, especially among vaccinated persons, are frequently the cause of an outbreak, the condition being not uncommonly mistaken for chickenpox. In this connection the " Vaccinia Variola " flocculation test may be of service (M.R.C. Report, No. 143, 1929).

The table on p. 59 makes it clear that since 1923 we have had to deal with a totally different type of disease. It is this type we know as variola minor. Variola minor is usually

ushered in by a sharp, sudden illness not unlike an attack of influenza and of variable duration. It is apt to pass through its stages more rapidly than does variola major and the lesions may even abort wholly or partially at any stage. Secondary fever is usually absent. Convalescence is uninterrupted and mortality is very low. The condition is probably the same as " alastrim " described as occurring on the American continent. Apparently variola minor breeds true and does not give rise to the major form of disease. Recent vaccination is completely protective. (" A Critical Review of the Clinical Features of 13,686 Cases of Variola Minor," L.C.C. Report, 1936.)

Variola minor appeared first in the north of England and gradually spread south till London began to be extensively involved in 1928. There seems to be a tendency for the incidence to increase in an invaded district for four or five years and then to decline, apparently after some form of " herd immunity " has been established. The first cases of the minor form of smallpox should be dealt with in exactly the same way as cases of the major type as it may be found possible to prevent its spread altogether, and as it is not always easy to decide whether these early cases are variola minor or an abortive form of severe smallpox possibly in persons vaccinated some time previously.

The Memorandum on Smallpox (Memo. 215/Med., 1938) issued by the Ministry of Health includes the following information and advice. " Experience has proved that variola major is more easily mastered than variola minor, because the public is alarmed and willing to aid the local authority in all measures of control. With the international conventions now in force, with vigilance of port health authorities and complete co-operation between the local authorities and the public, the risk of variola major again becoming seriously epidemic in this country has been much reduced." (See Port Sanitary Regs., 1933, p. 642).

" In dealing with variola minor, however, the problem of control has been more difficult. Owing to the mildness of the disease there was in the first place the difficulty caused by cases being either unrecognised or recognised too late to afford to their contacts the protection of vaccination. In the second place, vaccination of contacts was less readily accepted in a district in which the public had come to realise that the current smallpox was not a killing and rarely a disfiguring disease, and in the absence of general public alarm, or after its subsidence, the difficulties of making inquiries and tracing persons who had been exposed to infection were increased. The prominence which had been given to the rare occurrence of post-vaccinal nervous disease also discouraged the acceptance

of vaccination even after exposure to infection. The result was that in spite of great efforts and considerable expenditure, variola minor smouldered on in certain parts of the country, and the question arose whether its prevention should continue to be attempted on the same lines as variola major, or whether less energetic measures applicable to the less formidable infectious diseases would suffice. The majority of local authorities adhered to the established measures of smallpox prevention, but some took the latter course and in place of

SMALLPOX—ENGLAND AND WALES

Year.	Cases.	Deaths.	Fatality per 1,000 cases.
1902	13,923	2,464	176·97
1903	7,383	760	102·94
1911	295	23	77·97
1912	123	9	73·17
1913	115	10	86·96
1921	315	5	15·87
1923	2,485	7	2·82
1925	5,365	9	1·68
1927	14,767	47	3·18
1929	10,967	39	3·56
1931	5,664	9	1·59
1932	2,039	3	1·47
1933	631	2	3·17
1934	179	6	33·52
1935	1	—	—
1936	12	—	—
1937	4	—	—
1938	18	3	—
1939	1	—	—
1940	1	—	—
1941	—	—	—
1942	7	—	—

providing further hospital accommodation isolated a proportion of cases in their homes, and the procedure did not apparently hinder the decline of the local epidemic. Whatever justification there may be for relaxing the standard methods of control owing to the course of events, there is none for a policy of indifference ; variola minor is not invariably mild or entirely innocent of complications and permanent disfigurement. With an extensive rash its victim is unsightly and repellent, and when epidemic it causes an amount of invalidity which cannot be viewed without concern by those entrusted with the care of the public health.

The only outbreak of variola major during the war years occurred in Scotland in 1942 and valuable papers on the

subject appeared in the *B.M.J.* of 28th November, 1942, pp. 627–29, and *Proc. Roy. Soc. Med.*, March, 1943, pp. 227–36.

The following is a summary of the procedure which should at once be adopted by a medical officer of health on becoming aware that smallpox has appeared in his district.

1. The M.O.H. should visit the patient with the medical practitioner in charge of the case with a view to satisfying himself as to the diagnosis. If the patient is found to be suffering from smallpox, he should at once be removed to a smallpox hospital.

2. The M.O.H. should report the matter forthwith, preferably by telegram, to the Ministry of Health, as required in London by Article 14 (5) of the Sanitary Officers Order, 1926, and outside London by Article 17 (7) of the Sanitary Officers (outside London) Regulations, 1935.

3. Vaccination or revaccination should be offered to contacts. In doing so the following considerations should be kept in mind. The duration of the incubation period of smallpox is about twelve days counting to the onset of illness, that is, an average period of fourteen days before the outcrop of the characteristic focal rash. If this period is divided into three intervals comprising seven days, three days, and four days, then past experience suggests that a successful vaccination in the first interval will wholly prevent the attack, in the second it will more or less modify the eruption, and in the last it will have no influence on the development and course of the disease. The pertinent date is not when vaccination is performed, but when the reaction begins; if the reaction, which should be manifest on the third or fourth day, is delayed by any cause, then the rise of immunity is deferred. For this reason prevention can only be ensured by vaccination done within a day or two of exposure and followed by a normal reaction.

4. Contacts should be kept under medical surveillance for a period of sixteen days after the last exposure to infection. For this purpose it is seldom necessary or desirable to isolate them in their homes.

5. The M.O.H. should at once inform the public vaccinators and vaccination officers of the name and address of every case of smallpox as it occurs, in order that all practical methods may be taken to secure prompt vaccination or revaccination of persons willing to avail themselves of this protection.

County councils, county borough councils and metropolitan borough councils are responsible for the administration of the Vaccination Acts in their respective areas, and in a county district the M.O.H. should report his action to the county M.O.H.

The M.O.H. is himself empowered by the Public Health (Smallpox Prevention) Regs., 1917, to vaccinate or revaccinate contacts.

6. The infected house and its contents, together with the clothing of all persons known to have been in close contact with the patient, should be disinfected. In variola minor a less stringent standard of disinfection may be adopted at the discretion of the M.O.H.

7. It is important that all doubtful cases of the disease should at once be seen by the M.O.H., and, with this end in view, medical practitioners should be notified of the presence of the disease in the district, and invited to inform the M.O.H. promptly of any cases suspected to be smallpox.

8. In this connection the possible confusion with chickenpox should be borne in mind, as should also the fact that this disease can be made compulsorily notifiable by the L.A. on the advice of the M.O.H., in accordance with the procedure set out in Section 147 of the Public Health Act, 1936, and Section 305 of the Public Health (London) Act, 1936.

9. The M.O.H. should notify the M.O.'sH. of adjoining areas of the occurrence of smallpox, in order that they may take any precautionary measure which the circumstances require.

10. In order to ascertain the source from which the case of smallpox derived infection, careful inquiry should be made concerning the movements of the patient during the three weeks preceding the commencement of his attack, and particularly on the twelfth, thirteenth and fourteenth days prior to the onset of his illness. In this way, a case of smallpox which has not previously been recognised may be discovered.

11. Public vaccinators and M.O.'sH. can secure a gratuitous supply of lymph on application by letter, telegram or telephone to—

"The Government Lymph Establishment,
Colindale Avenue,
The Hyde,
London, N.W.9."

(See also Min. of Health Report No. 62, 1931, on "Smallpox Prevention.")

Vaccination was introduced by Jenner in 1798 when he successfully inoculated human beings with cow-pox. Prior to this, inoculation with smallpox material had been practised fairly extensively. In 1840 vaccination was provided free for all who cared to be vaccinated and inoculation with smallpox material was prohibited. In 1853 vaccination of all infants under the age of three months was made compulsory, and in 1867 public vaccinators had to be appointed by boards of guardians. In 1898 the age of compulsory vaccination was raised from three months to six. Vaccination in the home was substituted for stational vaccination and the use of glycerinated calf lymph took the place of arm-to-arm inoculation. (Note that it is only vaccination performed by the public vaccinator

that must be done with calf lymph. Arm-to-arm vaccination is not prohibited in the case of private practitioners, but it is never done.) The Act of 1898 also contained the first of the clauses providing for exemption on grounds of conscientious belief that vaccination would be prejudicial to health.

The present position regarding compulsory vaccination is as follows (Vaccination Acts, 1867–1907) :—

When the birth of a child is registered, the registrar gives the parent a notice in which are set out the legal requirements and the steps to be taken with regard to vaccination. In the notice are incorporated a form of declaration on which a parent can claim exemption and four blank certificates for the use of a medical practitioner :—

Certificate A. Postponement on account of child's health.
,, B. Postponement on account of the conditions of the house or local prevalence of infectious disease.
,, C. The insusceptibility of the child to vaccinia (whether as a result of previous smallpox or not).
,, D. Successful vaccination.

The form or the appropriate certificate when duly filled in is sent by the parent or medical practitioner to the vaccination officer, who makes the necessary entry in his register.

The registrar of births and deaths must send to the vaccination officer, at least once a month, a return of all births and deaths of children under twelve months which have, since the date of the last return, been registered in the district of the vaccination officer. When a child has reached the age of three months and one week, and the vaccination officer has not received in respect of it a form of objection or any certificate, he notifies the parent that the time is running out and usually calls at the home to make inquiry. If, when the child is four months and seven days, the vaccination officer finds the child not accounted for, he sends its name and address to the public vaccinator, who calls at the house and offers to vaccinate with Government lymph. If, at the end of six months and seven days from the birth of the child, the child is still unvaccinated, it is the duty of the vaccination officer to issue a notice to the parent that he is in default and, if this notice is disregarded, it is the officer's duty to take proceedings against the parent. The penalty for neglecting to have a child vaccinated is 20*s*.

No parent or guardian is liable to any penalty if within four months from the birth of the child he makes a statutory declaration before a commissioner for oaths, Justice of the Peace or other officer authorised to receive statutory declaration, that he conscientiously believes that vaccination would

be prejudicial to the health of the child and within seven days thereafter sends the declaration to the vaccination officer.

Under the Local Government Act, 1929, the functions relating to vaccination formerly discharged by boards of guardians were transferred to county and county borough councils to be administered by these councils as functions relating to public health. (See Ministry of Health Memo., L.G.A., 33, 9th January, 1930.)

The duties of public vaccinators are set out in detail in the Vaccination Order, 1930. The Order, among other matters, requires the public vaccinator to carry out revaccination of any person on request, to inspect all vaccinations not less than six days and not more than fourteen days after the operation, and to attend and treat free of charge any child requiring medical treatment as a result of vaccination.

The following instructions to vaccinators under contract are set out in the first schedule to the order:—

(1) Except so far as any immediate danger of smallpox may require, the public vaccinator must vaccinate only subjects who are in good health. As regards infants, he must ascertain that there is not any febrile state, nor any irritation of the bowels, nor any unhealthy state of the skin, especially no chafing or eczema behind the ears, or in the groin, or elsewhere in folds of skin. He must not, except of necessity, vaccinate in cases where there has been recent exposure to the infection of diseases such as measles, scarlatina, or diphtheria, nor where erysipelas is prevailing in or about the place of residence.

(2) If it be necessary to postpone vaccination on medical grounds a certificate to that effect must be given by the public vaccinator in the form prescribed by the Minister of Health or to the like effect—

(*a*) If in his opinion the child is not in a fit and proper state to be vaccinated ; or

(*b*) If in his opinion the child cannot be safely vaccinated on account of the condition of the house in which it resides or because there is or has been a recent prevalence of infectious disease in the district ; and in any such case the public vaccinator is required forthwith to give notice of such certificate to the medical officer of health of the district in the Form P. set out in the Fifth Schedule to this Order, or to the like effect.

(3) All public vaccinations are to be performed with glycerinated calf lymph, or with such other lymph as may be issued by the Minister of Health. If the parent or other person having the custody of the child requires that it shall be vaccinated with lymph issued by the Minister of Health, the vaccination must be performed with such lymph.

(4) The public vaccinator must keep such record of the lymph he uses for vaccination as will enable him always to identify the origin of the lymph used in each operation. He must not employ lymph supplied by any person who does not keep an exact record of its source.

(5) The public vaccinator must keep in good condition the lancets or other instruments which he uses for vaccinating, and he must not use them for any other purpose whatever. When vaccinating he must have with him the means of sterilising and cleansing his

instruments. He must cleanse and sterilise his instruments immediately before and after performing each vaccination. When once he has unsealed a tube of lymph he must never attempt to keep any part of its contents for the purpose of vaccination on a future occasion. In no circumstances whatever should the mouth be applied directly to the tube in which the lymph is contained for the purpose of expelling the lymph. In the case of ordinary capillary tubes an artificial blower may be properly used for this purpose.

(6) Vaccination should at every stage be carried out with aseptic precautions. These should include: 1st, the thorough cleansing of the surface of the skin before vaccination; 2nd, the invariable use of sterilised instruments; and 3rd, the effective protection of the vaccinated surface against extraneous infection both on the performance of the operation and on inspection of the results.

Advice should always be given to the person having the custody of the child as to the necessity of effective protection of the vaccinated surface until the scabs have fallen and the arm has healed.

(7) In all ordinary cases of vaccination or revaccination, the public vaccinator should vaccinate in one insertion preferably by a single linear incision or scratch not more than a quarter of an inch long merely through the epidermis. This incision should be made in the long axis of the limb. The lymph may be applied to the cleansed skin and the incision made through it, or the lymph may be applied to the incision immediately after the latter has been made. The lymph may be gently rubbed into the scratch with the side of the needle or lancet. In cases in which the public vaccinator or the vaccinee (or the parent or other person having custody of a child vaccinee) desires to obtain additional protection at one operation (*i.e.* where the maximum protection against smallpox is desired, or where the circumstances make it especially desirable to avoid risk of failure), the public vaccinator may, if he considers it necessary, increase the number of such insertions. The number of insertions should not exceed four, and they should be placed so as to avoid coalescence of the resulting vesicles. The aim of the public vaccinator should be to produce successful vaccination with the minimum of injury to the tissues. In no circumstances should the vaccinated area be cross-scarified or cross-hatched.

Opportunity should be taken by the public vaccinator to recommend that, in view of single-insertion vaccination, revaccination is advisable at an earlier period than if more insertions had been made than one.

(8) The public vaccinator must enter all cases in his register on the day when he vaccinates them, together with all particulars required in the register up to and including the column headed "Initials of persons performing the vaccination." The results of the vaccination are to be entered in the register upon the day of inspection and attested by the initials (in Column No. 13) of the person who makes the inspection. In cases of successful *primary* vaccination the public vaccinator must record the number of separate normal vaccine vesicles or groups of vesicles which have been produced. In cases of *revaccination* he must register as "successful" only those cases in which either vesicles, normal or modified, or papules surrounded by areolæ, have resulted.

When any operation (whether vaccination or revaccination) has to be repeated owing to want of success in the first instance it should be entered as a fresh case in the register.

In **Circular 1025**, 19th August, 1929, the Minister states that he "is of opinion that, in our present state of knowledge, and so long as the smallpox prevalent in this country retains its present mild character, it is not generally expedient to press for the vaccination of

children of school age, or of adolescents who have not previously been vaccinated unless they have been in personal contact with a case of smallpox or directly exposed to smallpox infection."

The Public Health (Smallpox Prevention) Regulations, 1917, give a medical officer of health power to vaccinate or re-vaccinate without charge any *contacts* of a case of smallpox willing to submit themselves to the operation.

In 1908 the percentage of vaccinations to births in England and Wales was 63·2 and in 1939 the figure was only 34·0. Of the efficacy of vaccination there can be no doubt, as the figures of the vaccinal condition of cases of smallpox occurring in any year afford abundant evidence. Thus in 1932 there were only four cases of smallpox in successfully vaccinated children under the age of fourteen years, whereas there were 623 in unvaccinated children of the same ages. The situation is summarised in the Ministry of Health Report, No. 8, 1921, as follows :—

"We know that the mortality from smallpox is much less now than in pre-vaccination times, that the greatest diminution in the smallpox mortality is found in the early years of life in which there is most vaccination ; that in countries in which there is much vaccination and revaccination relatively to the population there is little smallpox ; that in places where smallpox prevails it attacks a much greater proportion of the unvaccinated than the vaccinated, especially where the vaccinations are comparatively recent ; that in houses invaded by smallpox in the course of an outbreak not nearly so many of the vaccinated inmates are attacked as of the unvaccinated in proportion to their numbers ; that the fatality rate among persons attacked by smallpox is much greater age for age among the unvaccinated than among the vaccinated ; that the degree of protection conferred by vaccination corresponds to the thoroughness with which the operation has been performed, four marks affording much better protection than one or two ; that the protection afforded by vaccination wanes with lapse of time ; that improved sanitation, however beneficial in itself, cannot account for these facts ; and that though early diagnosis, prompt isolation of smallpox patients in suitable hospitals, effective disinfection, supervision of contacts, and other such public health measures are invaluable, they are no substitute for vaccination."

It is not certain to what degree the present vaccinal state of the population in this country acts as a check upon the spread of smallpox in a community. It is interesting to note that the incidence of recent years has not fallen most heavily upon those counties in England and Wales which show the lowest percentages of successful vaccinations. There is also a growing opinion amongst medical officers of health that the compulsory vaccina-

tion clauses, which are enforced only very rarely, are serving no useful purpose at the present time and that more progress would be made with infant vaccination if it were administered on a purely optional basis through the agency of maternity and child welfare organisations. (*Lancet*, 30th June, 1934, pp. 1414–1416, "The case for and against the abolition of compulsory vaccination of infants.")

The public dislike of vaccination has been accentuated by the occurrence in recent years of acute disease of the central nervous system (post-vaccinal encephalitis) as a complication of vaccination. Rather more than 100 such cases were noted during 1926–29, and in every instance the onset of the disease was within four weeks of vaccination, the average interval being about ten days. The mortality was nearly 50 per cent. A Ministry of Health committee investigated the matter and produced two reports (Cmd. 3148, 1928, and Cmd. 3738, 1930). The incidence of the complication is, of course, very small compared with the total number of vaccinations performed and seems to fall most heavily on children of school age undergoing primary vaccination. A similar condition very occasionally follows influenza, measles, whooping cough, chickenpox and probably other infectious processes. The committee recommended that one mark should be made on vaccination and revaccination in place of the four previously advocated, that primary vaccination should be performed in infancy and revaccination offered at five to seven years and again at fourteen to sixteen years, and that experiments should be made to see if lymph could be diluted further without impairing its efficacy. One-mark vaccination is now the method used by public vaccinators in accordance with the Vaccination Order, 1930, and practically as high a percentage of successful vaccination is obtained by this method as by the former more drastic procedure. (*Bull. Hyg.*, March, 1933, pp. 167–178, "Recent Advances in the Study of Vaccination against Smallpox," Wright; *Proc. Roy. Soc. Med.*, Vol. XXVII., No. 3, May, 1934, pp. 877–892; Report of the Committee on Immunization including Vaccination, British Medical Association, 1935.)

Lymph for vaccination at the public expense is prepared at the Government Lymph Establishment, Hendon, which is a department of the Ministry of Health. The seed material is derived from calf lymph, occasionally passaged through rabbits to maintain its quality. This seed lymph is rubbed into the carefully cleansed and scarified abdominal skins of healthy young calves. Resulting vesicles are removed on the fifth day and the pulp from each calf is kept separate. It is triturated with usually four times its weight of 50 per cent. sterile glycerine and distilled water made neutral, together with 0·1 per cent. clove oil. It is placed in a cold room at

— 10° C.[1] and is periodically examined for bacteriological contents; it is not issued till it passes the standards laid down by the Therapeutic Substances Regulations as to bacterial purity and potency. This may take months—up to three years. When lymph is urgently required purification is effected by ether, chloroform vapour or phenol. Great care has then to be taken not to jeopardise potency. The purified lymph is charged into sterile capillary tubes by air pressure and these are sealed hermetically. Each tube contains one dose. Lymph is also filled into sterile ampoules containing 25, 50 and 100 doses. Public vaccinators and others report upon the results. No lymph is issued unless it is derived from a calf which, after a post mortem examination, is found to be healthy.

Successful results are being obtained with a bacteria-free vaccine lymph produced by cultivating vaccinia virus on the chorio-allantoic membrane of chick embryos (*American J. Pub. Health*, November, 1937, pp. 1135–1140, Buddingh).

Influenza. Pandemics are known to have occurred in 1803, 1833, 1837, 1847, 1890 and 1918–1919. The 1918–1919 pandemic caused more deaths and disablement than the Great War—in India alone it is estimated that more than six million persons died of the disease. Young adults were specially affected in Great Britain, France and America, the largest proportion of deaths occurring in persons under forty-five years of age. From 1890 to 1917 about 70 per cent. of the deaths from influenza occurred in persons over forty-five years.

The following table gives the annual numbers of deaths from influenza and pneumonia.

It is always noted that during epidemics of influenza the death rate from respiratory diseases shows a marked increase. In normal times acute respiratory diseases are responsible for one-sixth of the deaths from all causes, and even in years in which influenza is epidemic they cause several times as many deaths as this disease. From 1915 to 1918 there was a close correspondence between the curves of cerebro-spinal fever, pneumonia and influenza in the British Army. The same winter and spring conditions favoured each. Brownlee has pointed out that epidemics of influenza appear to have their maxima from the beginning of January to the end of May, and that, when one epidemic follows another, an interval of thirty-three weeks usually intervenes. An analysis of the London figures from 1889 to 1896 shows this very clearly, but " our present knowledge of the epidemiology of influenza is insufficient to enable a central authority to give timely warning of a serious epidemic."

The work of Smith, Andrewes and Laidlaw (*Lancet*, 8th July,

[1] 10° below zero centigrade.

Year.	Deaths from Influenza.		Deaths from Pneumonia (all forms).	
	England and Wales (including London).	London.	England and Wales (including London).	London.
1917 . .	7,289	751	39,832	5,638
1918 . .	112,329	13,085	59,666	7,909
1919 . .	44,801	4,259	38,949	4,630
1920 . .	10,665	1,364	37,149	5,315
1921 . .	8,995	1,024	34,708	4,901
1922 . .	21,498	2,600	40,930	6,578
1923 . .	8,461	764	33,413	4,334
1924 . .	18,986	1,680	38,970	5,294
1925 . .	12,721	1,082	36,990	4,795
1926 . .	8,936	806	32,339	4,347
1927 . .	22,263	1,815	37,242	4,560
1928 . .	7,754	590	31,014	4,159
1929 . .	29,084	3,118	43,486	5,883
1930 . .	5,019	366	27,724	3,450
1931 . .	14,409	1,121	33,573	4,471
1933 . .	22,890	2,234	30,059	3,584
1936 . .	6,057	533	28,182	3,378
1937 . .	18,635	3,162	29,532	6,403
1938 . .	4,847	617	25,945	5,479
1939 . .	9,033	682	22,207	2,648

1933, p. 66, and *Brit. J. Exp. Path.*, XVI., 1935, p. 566) showed that a filtrable virus is present in the throats of cases in the early stages of influenza which is capable of producing disease in ferrets. Ferrets which had recovered from an attack proved resistant to infection; their serum possessed neutralising properties for the virus, and a high percentage of sera from human influenza convalescents showed similar neutralising power. More recently it has been found possible to infect mice with the virus. It appears that epidemic influenza is primarily a virus infection, but all strains of human influenza virus are possibly not serologically identical. Attempts have been made to differentiate this disease, under the name of epidemic influenza, from other febrile catarrhs. (M.R.C. Report 228, 1938, "A Study of Epidemic Influenza with special reference to the 1936–37 Epidemic"; *Lancet*, 11th March, 1939, pp. 589–91, "Epidemic Influenza," and 4th October, 1941, pp. 387–89, "Influenza in England in 1940–41.")

The incubation period appears to be about forty-eight hours. Case mortality is difficult to estimate, but in 1918 it amounted to 10 per cent. in some ships of the British Navy and 5 per cent. in the Royal Herbert Hospital, Woolwich.

The School Epidemics Committee of the Medical Research Council concluded from their studies that there was no evidence

of an actively acquired immunity lasting for as long as one year. Indeed, boys who had influenza in one year were more, not less, likely to contract the disease in the next year than their companions who had passed through the first epidemic without being attacked. It is reasonable to suppose that a recent attack leaves a member of the more susceptible class better able for a time to resist another attack than the members of the less susceptible class ; after the passage of a few weeks or months, however, this transient immunity may wear off, and he may regain his original degree of susceptibility. (M.R.C. Report No. 227, 1938, " Epidemics in Schools.")

The rapidity of the spread of influenza is only limited by the speed of human travel and its progress, like that of other diseases apparently spread by droplet infection, is hardly stayed by any public health measures at our disposal. It is probable that massive infection may be transmitted by loud talking, up to a distance of 4 feet, and by coughing or sneezing, up to 10 feet. It is advisable that places where crowds of people collect should be avoided so far as possible during epidemics, and that rooms should be well ventilated. In 1918 the Public Health (Influenza) Regulations empowered local authorities to restrict the duration of public entertainments (*e.g.* cinemas) to three or four hours and to require an interval of not less than thirty minutes between two entertainments, during which time the hall had to be effectually and thoroughly ventilated. If schools were closed on account of influenza it was advised that a notice should be served on the proprietors of cinematograph exhibitions forbidding the admission of children during the continuance of the school closure. These Regulations were withdrawn in May, 1919.

Health authorities should endeavour to inform the public, in the various ways at their disposal, as to the nature and gravity of the disease, the importance of an adequate diet and the precautions to be taken in case of attack. It is important that a nursing service should be made available for infected households and that institutional treatment should be provided where necessary. Those in attendance on patients may wear masks for protection against the coarser droplets from an infected person, but the gauze mesh must be close (44 or more to the inch) and of at least four thicknesses. Gargling alone is very unlikely to protect against infection by a virus which may be conveyed through the nasal mucosa. Vaccine containing living virus has been tried, but this work is still in its experimental stage. Inactivated virus gives less effective immunisation in the case of ferrets. A formolised influenza—A virus vaccine prepared in the developing egg presents future possibilities. (Min. of H. *Memo.* 2/Med., 1939 ; J. of Exper. Med., Vol. 73, No. 3, 1st March, 1941, " A Complete Vaccine against Influenza Virus," Horsfall, F. L., Lennett, E. H., and Rickard,

E. R.; "Control of Common Fevers," "Epidemic Influenza," Andrews, C. H., Lancet Ltd., 1942.)

Pneumonia. The incidence of pneumonia falls heavily on those below six years of age, it then diminishes to fifteen, but increases for every year after that. In people over sixty-five the condition is a serious one. Males are more affected than females. Poverty, alcoholism and trauma appear to be predisposing factors. The infectious fevers and particularly measles, whooping-cough and influenza are the most active predisposing causes of broncho-pneumonia. Negroes and other coloured races in the tropics suffer severely.

Acute primary pneumonia and acute influenzal pneumonia are notifiable under the Public Health (Infectious Diseases) Regulations, 1927, and it is the duty of the M.O.H. to see that such inquiries as may be necessary are made in connection with the cases. All cases should be regarded as infectious, and require careful nursing; admission to hospital is essential in some instances, though it must be remembered that it is often dangerous to remove patients suffering from influenzal pneumonia.

Great advances have been made in the treatment of pneumonia by the use of the sulphonamide group of drugs.

Atypical pneumonia is a fairly widespread and usually mild disease that has received adequate recognition only during recent years. The clinical picture is hardly characteristic and diagnosis is possible in many cases only by X-ray examination. Transmission is probably by droplet infection and there is no great tendency to spread in epidemic fashion. It is not susceptible to the action of the sulphonamides. No bacterial cause has been found, but the disease is thought to be due to some virus possibly related to those of psittacosis, meningopneumonitis and lymphogranuloma inguinale. The influenza virus is not apparently concerned, and it is of interest that the Rickettsia of Q fever gives rise to a form of pneumonia.

In 1939 bronchitis, pneumonia and other respiratory diseases caused 8·4 per cent. of all deaths in England and Wales. The mortality rate for pneumonia varies considerably in England and Wales—in the north it is about twice that in the south, and it is almost three times as great for males in the county boroughs of the north as for males in the rural districts of the south. Although the results of chemotherapy are undoubtedly spectacular, the fatality rate is still as high as about 10 per cent.

Statistical evidence points to sharp changes of temperature, particularly in their effect upon the aged, as the real basis of the evil reputation of climate in relation to respiratory disease. In this country the maximum mortality is reached in March, a month showing great variation of temperature. It is probable, too, that fog associated with a fall in temperature tends to produce an increase in mortality from respiratory diseases.

(Min. of H. *Memo.* 189/Med., 1935; M.R.C. Report No. 192, 1934, "Housing Conditions and Respiratory Disease"; see also p. 523.

Epidemic Infective Hepatitis is not due to the same causal organism as Weil's disease but in all probability to an ultra-microscopic virus responsible for a group of diseases transmitted by direct contact and possibly by droplet infection.

Jaundice is one of the afflictions of armies in the field, not only in the late war but also in the present one. In 1936 jaundice occurred in a group of people who had been inoculated several months previously with a yellow fever vaccine, and since then a hepatitis indistinguishable from infective hepatitis has developed both in children and in adults passively immunised with mumps and measles convalescent and adult serum. In these cases the interval between the infection and symptoms has varied but was usually two to three months, while in infective jaundice it was usually twenty to thirty days. This difference suggests that the infective organism is not the same. In some of the cases the infection was transmitted to contacts, and laboratory workers handling serum from patients have also contracted the disease.

More recently some of the allied troops immunised with certain batches of yellow fever vaccine were affected with jaundice and jaundice was discovered among the donors of the serum with which the batches were made. Findlay and Martin infected volunteers by introducing nasal washings in physiological saline taken from patients in the pre-icteric or early icteric stages of jaundice following yellow fever immunisation. Jaundice was produced after incubation periods of twenty-eight, thirty and fifty days. There was variation in severity but the symptoms were those of infective jaundice. The agent responsible for the jaundice was present in the serum as well as in the nasal washings and everything suggests that it is a virus and not a toxin.

In cases that have ended fatally necrosis of the liver has been found on post-mortem examination. The incubation period of the natural disease is about a month, while, after serum, three or four months may elapse before jaundice develops. The period of infectivity, though not determined, is possibly about ten days, starting before jaundice appears. In this country the majority of recorded outbreaks have occurred in rural areas and mostly in children and young adults; the incidence of children under school age has been low.

There is no evidence to show that epidemics of this disease are transmitted by contaminated food or water nor have they the explosive character of such outbreaks. The question arises as to whether this hypothetical virus is not also responsible to some extent for the jaundice seen in V.D. clinics and occa-

sionally in T.N.T. factories; may it not cause hepatitis by attacking livers already affected with arsenical drugs or liver poisons? Much useful information has been gained from the occurrence of jaundice after immunisation with mumps and measles convalescent serum and in soldiers actively immunised with yellow fever vaccine. Some of the facts do not fit into the expected pattern and more are needed. At the request of the Ministry of Health the Medical Research Council is undertaking a special investigation into the causes of the increased incidence of the different forms of jaundice.

No effective measures of control are available, but the public should be warned that the disease may be infectious and that every case should be isolated at the onset and for at least a fortnight afterwards. The infection may, however, assume a mild form without jaundice and such cases may be responsible for the spread. School closure as a preventive measure is not indicated and only results in the dissemination of the disease over a wide area as in the case of acute poliomyelitis. ("Control of the Common Fevers," pp. 304–12, "Catarrhal Jaundice," Pickles, W. N., The Lancet, Ltd., 1942; War Office Army Med. Dept. Bull. 15, October, 1942; *Lancet*, 16th January, 1943, pp. 83–88; *Lancet*, 29th May, 1943, pp. 675–78, Ford, J. C.; also pp. 678–80, Findlay, G. M. and Martin, N. H.).

Mononucleosis (Glandular Fever). Three types of this disease have been described: (*a*) *Glandular*, in which different groups of glands are involved with pyrexia and in some cases tonsilitis without exudate; (*b*) *anginose*, usually with a long prodromal stage after which a pseudo-membrane appears on the fauces and there is often enlargement of the spleen; (*c*) *febrile*, onset is abrupt with sore throat and fever, and later there is glandular enlargement and very often a rash.

The blood picture shows an increase of white cells with a high percentage of monocytes. The anginose type may be mistaken for diphtheria and the rash of the febrile type is often indistinguishable from rubella. Infectivity is slight and the disease is probably spread by droplet infection. The patient, as well as immediate contacts, should be isolated for a fortnight.

Cerebro-spinal fever. Cerebro-spinal fever is a notifiable infectious disease of the central nervous system affecting chiefly the meninges of the brain and spinal cord. It is due to the *N. meningitidis*. It is usual to adopt Griffith's (1917) broad classification of the organism into Group I (types I and III) and Group II (types II and IV). Group II is normally of low pathogenicity—it can produce meningitis but as a rule only in highly susceptible subjects, especially infants—whereas Group I has much greater epidemic potentialities. For all practical purposes at the present time only the meningococci of Group I need be taken into consideration in efforts to control the spread

of cerebro-spinal fever. Few outbreaks were recorded in this country till 1907–1908, when 1,238 cases with 838 deaths were reported in Glasgow. In 1915–1917 the incidence was marked among troops and civilians, but by 1923 notifications had returned to the pre-war level. A gradual increase has been noted of recent years, and in 1931 the cases numbered 2,157 and the deaths 1,440. In 1942 there were 6,029 cases notified with 1,206 deaths. The majority of cases occur in children under five, but outbreaks may occur among older children and among adults in special communities such as residential schools and camps. Such outbreaks have at times been associated with overcrowding, bad ventilation, fatigue and inclement weather. The incubation period is variable, and may be as short as twenty-four hours or as long as ten days, though it is usually from three to five days ; the duration of the illness may be only a few hours in the most severe and fatal type or months in the recrudescent type. Various forms of paralysis may persist after convalescence. In a mixed series of cases skilfully treated a case-mortality of 5 per cent. or even less should be attainable. Diagnosis may be made on (1) clinical symptoms—headache, vomiting, pyrexia associated with slow pulse, stiffness of the neck and Kernig's sign, and (2) examination of the cerebro-spinal fluid, in which polymorphonuclear leucocytes containing meningococci are usually found. This procedure may, at the same time, have an immediate therapeutic effect in relieving headache, etc., due to the increased pressure of the fluid which may rise to 300 mm. The rate of decompression should be slow.

The disease is transmitted by droplet infection, but it is unusual for a sufferer to have contracted the disease from another patient. Unrecognised carriers of the meningococcus are the main source of infection and chronic carriers are found more especially among persons with unhealthy conditions of the nose or throat.

Extensive nasal swabbing to detect persons in a district who may be carrying the meningococcus is impracticable and has been found to serve no useful purpose in controlling the incidence of the disease. For the proper study and control of outbreaks in residential schools and other limited communities, however, systematic swabbing sometimes gives valuable indications. To serve any useful purpose the swabs should be skilfully taken and immediately inoculated on to culture plates. The upper end of the posterior pharyngeal wall should be swabbed and every effort made to avoid contamination with saliva. The culture plates should be warmed to blood heat and it should be remembered that the most careful bacteriologist may sometimes fail to find meningococci, especially when they are masked by other micro-organisms. If the establishment of a

negative result is of importance, it is well that at least two successive bacteriological examinations of swabs should be made.

Overcrowding must be avoided and in this connection the work of Glover (M.R.C. Report No. 50, 1920) should be remembered. He found that, if overcrowding occurred in a military unit not previously subjected to overcrowding conditions, there was a marked rise in the carrier rate which became noticeable usually in about a fortnight's time. Peace standards of accommodation in barracks are 60 feet of floor space and 600 feet of cubic space per person with 3 feet between the edges of beds, but under war-time conditions such standards are impracticable and in hutments with double bunking the floor space and cubic space may be reduced to almost one-half the peace standards. A sharp rise in the non-contact carrier rate to over 20 per cent. is an indication that an outbreak of cerebro-spinal fever may be expected, and in peace-time such high carrier rates may be reduced by spacing out the beds, though the reduction takes place much less rapidly than the rise. In school dormitories the space between bed centres should not be less than 3 feet.

The isolation in hospital of contacts or known carriers should not be attempted as intermittently the meningococcus is a common inhabitant of the nasopharynx and only occasionally produces disease. Contacts should, however, be noted and should be seen for at least ten days in order to be assured that they are in good health. Temporary carriers in good hygienic conditions with plenty of fresh air and exercise clear up rapidly without treatment. As young children are especially susceptible to the disease, they should be kept away as much as possible from persons who are habitually in close contact with clinical cases and the danger of kissing, sneezing and coughing should be emphasized. The meningococcus commonly disappears from the nasopharynx of healthy persons within two or three weeks and it is usually sufficient if children of school age who have been in contact with a clinical case of cerebro-spinal fever are excluded from school for three weeks. Meanwhile, the hygienic conditions of the school should be investigated to see that there is no overcrowding and to ensure that the children get as much fresh air as possible.

The various sulphonamide derivatives have revolutionised treatment and improved prognosis. There are four sulphonamide derivatives the value of which in the treatment of cerebro-spinal fever has been substantiated; they are: sulphonilamide, sulphapyridine, sulphathiazole and sulphadiazine.

Early administration and adequate dosage are essential and chemotherapy should be begun without waiting for bacteriological confirmation. Large doses in the first forty-eight hours

should be given as high concentrations at a later stage may be comparatively ineffective. The standard routine treatment of mild and moderately severe cases is the administration of sulphapyridine tablets by mouth.

In cases where treatment has been delayed, to ensure rapid absorption sulphapyridine should be given by intravenous injection, and in fulminating cases the drug should be administered simultaneously both intravenously and intramuscularly.

The total dosage recommended is up to 9 gm. in twenty-four hours for an adult for two and a half to three days and then very gradually reduced over the next six days. The initial dosage for infants and young children should be much higher proportionately than for adults. The following dosage for the first two and a half to three days of treatment is suggested for sulphonilamide or sulphapyridine, although there is evidence that somewhat lower dosage of the latter is often successful.

Age period in years .	0–	2–	5–	10–	15+
Daily amount in grammes	3	$4\frac{1}{2}$	6	$7\frac{1}{2}$	9

There is no specific remedy known that is as effective as a prophylactic measure such as gargling, etc., and the use of sulphonamides as prophylactics is not recommended. (Min. of H. Memo. 234/Med., 1940 ; *Lancet*, 28th Oct., 1939, p. 921, and 6th January, 1940, p. 42, Banks, H. S. ; War Office Memo. on Cerebro-spinal Fever among Troops, 1942 ; *B.M.J.*, 24th April, 1943, p. 497, Beeson, P. B. and Westerman, E., also p. 501, Jubb, A. A.)

Acute poliomyelitis (including polio-encephalitis and polio-encephalo-myelitis) is often known as "infantile paralysis," although the disease is found not infrequently in adults and paralysis does not always occur. The disease has assumed world-wide prevalence in recent years. Severe epidemics occurred in Denmark in 1934, in Sweden in 1936 and in Ontario, Chicago and Melbourne in 1937. In Denmark the case rate was as high as 124·9 per 100,000 population. In England outbreaks have occurred from time to time (Cumberland 1910, Devon and Cornwall 1911), while in 1926 prevalence was fairly high throughout England and Wales. The condition is notifiable and notifications in England and Wales numbered 1,397 in 1926 and 674 in 1942. It is a disease of temperate climates and is most marked in the autumn months. Incidence is highest in the second year of life (one to five years) and falls more heavily on males than on females. Case mortality varies from 10 to 25 per cent., and is greater at ages above ten years. The disease is caused by a filter-passing virus, the presence of which has been demonstrated in the naso-pharynx of patients and of others who were not even known contacts. Apparently healthy persons may spread the infection. Milk has been

thought by some to be a vehicle of infection, but the evidence is not generally accepted. It is now recognised that the gastro-intestinal tract is the portal of entry for the virus of polio-myelitis, and the virus has been found in the fæces of persons suffering from the disease. It has been isolated from house-flies and has been demonstrated in sewage in localities in which the disease was present and may persist for a long time. Contaminated drinking water may be looked on as a potential source of infection though no case has, as yet, been traced to water. The virus may persist for a hundred days in sterile water stored in the dark, and modern methods of chlorination leave it unaffected. The spread by droplets through the naso-pharynx is probably of minor importance, if it occurs at all. (*B.M.J.*, 1st May, 1943, p. 545, also 22nd May, 1943, p. 643.) The incubation period is probably from two to ten days, usually three to four. Clinically the disease usually shows a febrile initial stage lasting five or even ten days; a pre-paralytic stage with pains in the back and limbs, stiffness of the neck and spine, muscular twitchings, hyperæsthesia, etc.; and a paralytic stage. The extent to which paralysis persists depends on the degree of damage to the spinal cord.

Diagnosis depends on the clinical findings together with the result of the examination of the cerebro-spinal fluid. In the pre-paralytic stage this fluid is usually under somewhat increased pressure, has a hazy appearance and shows an increase in the number of cells. The ratio of lymphocytes to polymorphonuclear cells increases as paralysis approaches. Globulin is increased and the chlorides are not diminished.

Treatment by convalescent serum has been advocated by various workers (*Lancet*, February, 1932, p. 469, Macnamara and Morgan), but is of service apparently only when given before the onset of paralysis. In certain acute types of poliomyelitis paralysis involves the muscles of respiration, and to maintain life artificial respiration is necessary. This is provided by some form of mechanical respirator such as the Drinker, the Bragg-Paul or the Both apparatus. It is, therefore, essential that all general hospitals throughout the country should have an apparatus of this nature and medical practitioners should be notified as to where it is available. (M.R.C. Report No. 237, 1939.) An orthopædic surgeon should have control of the case whenever paralysis appears. Early splinting of affected limbs, followed later by re-education of muscles and carefully applied massage and electrical treatment, should be practised. Paralysis tends to become stationary after about two years and subsequent treatment of an operative character may be required. The medical officer of health should endeavour to provide hospital accommodation for suspected cases, should search for missed cases and should do what he can to prevent spread of infection.

Even the urine and excreta as well as the naso-pharyngeal secretions of a patient may be infective, so special care must be exercised by attendants. Children in the affected household should be excluded from school for three weeks after isolation of the patient. The Ministry of Health advise that the balance of advantage is in favour of not closing a residential school on the appearance of poliomyelitis. If the school is closed infection may be more widely distributed and pass out of control and supervision. (Memo. 166/Med., Ministry of Health, December, 1936 (revised); *Lancet*, 4th June, 1938, pp. 1288–1291, MacNalty; *Proc. Roy. Soc. Med.*, Epidem. Sect., Vol. XXXII No. 3, March, 1939, "Epidemiological Problems of Poliomyelitis in Schools," Smith, R. E.; *Med. Journal of Australia*, 3rd February, 1940, pp. 148–56, Hamilton, D. G.)

Encephalitis lethargica is a disease which has shown some prevalence in this country since 1918. It is probable, however, that the condition has occurred in epidemic form from time to time in past years. The disease is notifiable and the year of greatest incidence was 1924, when 5,039 cases were reported. In 1942 notifications numbered 148, deaths amounting, however, to 590. The high ratio of deaths to notified cases is evidence of the prolonged and ultimately lethal effect of the virus.

The pathology of the disease consists mainly of a perivascular cellular infiltration of lymphocytes, more especially in the neighbourhood of the nuclei of the third nerve or the basal ganglia. The causal agent is thought to be an ultra-microscopic filtrable virus, probably similar to those producing vaccinia, herpes, rabies and poliomyelitis.

The disease is most prevalent in winter and spring, persons of any age may be attacked and both sexes suffer equally. The case mortality is between 20 and 50 per cent. The duration of the incubation period is unknown, a prodromal stage of indefinite illness lasting usually about seven days follows, and finally the acute stage supervenes, during which high temperature, stupor, skin eruption, paralysis of accommodation, ptosis and various other symptoms may be present. The sequelæ are of importance :—

1. Mental symptoms—irritability, maniacal outbursts, complete change of moral character—usually seen in children and young adults.
2. Parkinsonian syndrome—occurs in about half the number of cases that do not make a satisfactory recovery. It is of grave significance and may occur years after the onset of the disease.
3. Excito-motor sequelæ—myoclonus, muscular spasms, etc.
4. Paralysis, sensory symptoms, respiratory spasms.

Infectivity is low and association between notified cases is rare. Mild and missed cases probably help to spread the disease. The medical officer of health should assist in the

search for mild and abortive cases, provide hospital accommodation and laboratory assistance where necessary, and follow up cases with a view to recording in particular the presence of mental sequelæ. It is now possible to bring within the scope of the Mental Deficiency Acts certain types of patients suffering from the after-effects of this distressing condition.

Child contacts should be excluded from school, as a precautionary measure, for three weeks after the isolation of the patient. (Ministry of Health Memo. 45/Med., February, 1929 ; "Encephalitis Lethargica," Scottish Board of Health, 1926 ; MacNalty's "Epidemic Diseases of the Nervous System," London, 1927).

Tuberculosis. The following table, taken from the Registrar-General's Statistical Review for 1937, shows the standardised mortality from respiratory and non-respiratory tuberculosis from 1851 to 1937.

STANDARDISED MORTALITY FROM TUBERCULOSIS, RESPIRATORY AND NON-RESPIRATORY, AND MORTALITY AT AGES 0–5, 5–10 AND 10–15 FROM NON-RESPIRATORY TUBERCULOSIS, PER MILLION LIVING, 1851–1937. PERCENTAGE CHANGE DURING EACHD ECADE.

	All forms. All ages (stand.)		Respiratory All ages (stand.)		Non-respiratory				
					0–5	5–10	10–15	All ages (stand.)	
	M.	F.	M.	F	P.	P.	P.	M.	F.
	Death rates per million living.								
1851–60	3,477	3,483	2,694	2,854	4,470	640	319	783	629
1861–70	3,357	3,177	2,612	2,578	4,496	528	270	745	599
1871–80	3,080	2,701	2,359	2,119	4,460	505	257	721	582
1881–90	2,656	2,251	1,966	1,672	3,959	555	307	690	579
1891–1900	2,285	1,780	1,633	1,226	3,517	518	301	652	554
1901–10	1,891	1,424	1,358	951	2,556	501	303	533	473
1911–20	1,705	1,210	1,306	868	1,544	444	303	399	342
1921–30	1,109	888	868	677	836	265	182	241	211
1931	976	772	780	601	651	211	148	196	171
1932	913	727	718	562	656	195	135	195	165
1933	901	707	729	559	563	183	118	172	148
1934	832	657	669	512	528	183	120	163	145
1935	774	610	627	486	432	160	103	147	124
1931–35	879	695	704	544	568	187	125	175	151
1936	744	578	601	457	429	159	99	143	121
1937	739	584	595	459	454	139	106	144	125
	Percentage change from previous decade.								
1861–70	−3	−9	−3	−10	+1	−17	−15	−5	−5
1871–80	−8	−15	−10	−18	−1	−4	−5	−3	−3
1881–90	−14	−17	−17	−21	−11	+10	+19	−4	−1
1891–1900	−14	−21	−17	−27	−11	−7	−2	−5	−4
1901–10	−17	−20	−17	−22	−27	−3	+1	−18	−15
1911–20	−10	−15	−4	−9	−40	−11	0	−25	−28
1921–30	−35	−27	−34	−22	−46	−40	−40	−40	−38
1934–37	−30	−32	−28	−29	−45	−39	−41	−38	−39

During the 60 years between 1851–60 and 1911–20 phthisis mortality at 15–20 declined by 67 per cent. for males and 68 per cent for females ; at 20–25 it fell by 67 per cent. for males and 69 per cent. for females, and at 25–35 by 58 per cent. for males and 71 per cent. for females. The corresponding decline in the equivalent average rates [1] under 65 was 53 per cent. for males and 64 per cent. for females. During the period of about 12 years between 1911–20 and 1926–30 phthisis mortality at 15–20 fell by 24 per cent. for males and 12 for females ; at 20–25 it fell by 22 per cent. for males and only 4 per cent. for females, and at 25–35 by 29 per cent. for males and 19 per cent. for females. In the nine years, from 1926–30 to 1937, the decline at 15–20 amounted to 39 per cent. for males and 33 per cent. for females, at 20–25 it was 26 per cent. for males and 18 per cent. for females, and at 25–35 there was a fall of 30 per cent. for males and 24 per cent. for females.

The regional distribution indicated that for males the standardised rate was highest in Wales, Greater London and the North, whilst for females it was very much higher in Wales than elsewhere, and below the general average in Greater London. For males this rate was lowest in the East and for females in the South-East outside Greater London. Regional differences in mortality were greatest at 5–25, but the effects of urbanisation were most pronounced amongst males over 45, the London rates being more than double those in the rural districts at ages 45–75.

There has been a definite increase in deaths from tuberculosis since the beginning of the present war, both in England and Wales and in Scotland, although the adverse trend slackened during 1941 and 1942. All age-groups have been involved to some extent, but children, young adults (especially females) and older males appear to have suffered most. The death rate per million from respiratory tuberculosis among young women between the ages of fifteen and twenty-five rose from 762 in 1939 to 881 in 1940, compared with a rise in the death rate at all ages for both sexes from 535 to 587. If the figures for England and Wales in 1941 are compared with the averages for 1938 and 1939, the increase for pulmonary tuberculosis was about 10 per cent. and for non-pulmonary tuberculosis about 21 per cent. The total number of deaths from pulmonary tuberculosis in 1942 was 20,987 and from all forms of the disease 25,547—11 per cent. fewer than in 1941. An outstanding feature of non-pulmonary tuberculosis in recent years has been the increase in the incidence and mortality from tuberculous meningitis. (M.R.C. Special Report, No. 246, 1942.)

Primary notifications of pulmonary tuberculosis numbered 40,629 in 1942, 29·2 per cent. relating to persons between the

[1] Rates in a population containing equal numbers at each age.

ages of 15 and 25. Primary notifications of non-pulmonary cases in the same year numbered 11,990.

The tubercle bacilli found in man may be of either human or bovine type. A. S. Griffith reviewed the position in *Tubercle*, August, 1937, pp. 529–43, and compiled the following table giving English statistics for, approximately, the preceding twenty-six years :—

ENGLISH STATISTICS

Variety of Tuberculosis.	Number of Cases.	Percentage of Cases infected with the Bovine Type of Bacillus.		
		Under 5 years.	5–15 years.	All ages.
Cervical gland . .	126	90·9	53·4	50·0
Lupus . . .	191	58·4	44·4	48·7
Scrofulodermia . .	60	53·3	43·3	36·6
Bone and joint . .	533	29·5	19·1	19·5
Genito-urinary . .	23	—	—	17·4
Meningeal . .	265	28·1	24·5	24·6
Autopsies . .	187	28·6	15·5	22·5
Miscellaneous . .	23	33·3	9·1	8·7

No reference to pulmonary tuberculosis is made in the above table, but it should be noted that in Denmark the bovine bacillus has been found in 5 per cent. of 1,774 pulmonary cases and in Holland in 6·4 per cent. of 204 cases. Griffith and Smith in an article in the *Lancet*, 26th March, 1938, p. 739, showed that 9·1 per cent. of 342 pulmonary cases from rural and small urban districts in the north-east of Scotland and 4·4 per cent. of 294 pulmonary cases from the City of Aberdeen yielded tubercle bacilli of the bovine type.

Among factors predisposing to pulmonary tuberculosis must be classed poverty, lack of adequate food, bad housing, dirt and alcoholism. Dusty trades, especially those dealing with siliceous material, are accompanied by high phthisis death rates.

An investigation into the occupations and working hours of cases of pulmonary tuberculosis notified in Glasgow during the war years 1939 and 1940 showed that a combination of overwork, strain and ill-spent leisure was playing a major part in producing the increased number of notifications and deaths. It was observed that little increase had occurred among persons whose hours of work had remained within reasonable limits, but that a higher incidence of the disease had been noted among workers in heavy and in medium heavy industries where 67 per cent. of the former and well over 40 per cent. of the latter were working in excess of this standard. In addition, 40 per cent. of the housewives notified during 1941 were employed in part-

time work in addition to their household duties. (*B.M.J.*, 27th September, 1941, pp. 436–7.)

Insanitary overcrowded areas nearly always show a high death rate from pulmonary tuberculosis. Thus in certain districts in Liverpool, containing courts with back-to-back houses, the phthisis death rate was 4 per 1,000 (average of three years). The death rate from phthisis in the same areas, after reconstruction, fell to 1·9 per 1,000 (average of three years). An interesting review of "The Mortality from Tuberculosis in Ipswich during the Hundred Years 1841–1940," by A. M. N. Pringle, may be found in *The Medical Officer*, 10th, 17th and 24th April, 1943.

Macgregor of Glasgow in his annual report for 1926 has shown that there is a diminished incidence of pulmonary tuberculosis associated with an increase in the size of house ; the association is most marked in the case of females. Glasgow, it should be remembered, contains large numbers of one and two apartment tenements. In an investigation into the incidence of tuberculosis in certain Tyneside districts (National Association for the Prevention of Tuberculosis, 1933), Bradbury concluded that overcrowding is a cause and not simply an accompaniment of tuberculosis. The Registrar-General in his Statistical Reviews for 1934 and 1935 commented on the association between the phthisis mortality of females aged 15–25 and a high average of persons per room.

In an interesting investigation carried out by the Lancashire group of tuberculosis officers it was found that, among 1,486 children under five years of age living in 1,063 homes in each of which was at least one tuberculous adult, the death rate from non-pulmonary tuberculosis was nine times greater in the age-group 0–1, fourteen times greater in the age-group 1–2 and nineteen times greater in the age-group 2–5 than in the similar age-groups in the whole of the county of Lancaster. These figures were obtained from households where the infected adult had a positive sputum. When the adult had a negative or no sputum the ratio was not so high, but was considerably above the controls. (Report published in 1929, noted in *B.M.J.*, 18th May, 1929, p. 918.) Pulmonary tuberculosis in the adult may be due to invasion by the tubercle bacilli during childhood, with possibly little or no indication of any disease; and unfavourable conditions in later life may lead to a dissemination of the disease from some focus in which the bacilli have been lying inactive for years. Other workers believe that pulmonary tuberculosis of the adult type requires two different infections, a primary infection that produces allergy in the lung parenchyma and a re-infection or super-infection of the lung from without with tubercle bacilli. It is possible, however, that mild tuberculosis in childhood or youth confers a certain degree

of immunity against subsequent tuberculous infection, and the disease is less rampant in such immunised communities. When tuberculin tests are applied to children, positive reactions increase from 9 per cent. in the second year of life to 94 per cent. in the thirteenth and fourteenth years. These results indicate frequency of infection, but not, of course, frequency of tuberculosis as a disease in children. The real danger is probably massive or prolonged infection sufficient to overpower the forces of natural resistance. Karl Pearson showed that out of 10,980 couples, in which at least one partner was tuberculous, both husband and wife were tuberculous in 1,296 couples, *i.e.* one couple out of 8·4—a higher proportion than could be accounted for by chance alone. (See *Lancet*, 25th February, 1928, p. 406, "Conjugal Tuberculosis"; Annual Report, C.M.O., Min. of Health, 1934, p. 83.)

The bacilli may be inhaled, ingested or inoculated. In dust they may retain their vitality for considerable periods; hence a child allowed to crawl about dirty floors and streets may conceivably become infected in this way. The percentage of samples of milk in large cities in which bovine bacilli have been found varies from 2·1 to 11·1, with an average of 6·7 (69,901 samples), and records of samples examined in such cities show that about 5 to 10 per cent. of farmers are sending out milk infected with virulent tubercle bacilli. Pasteurisation of milk, unless carried out as indicated in the Milk (Special Designations) Regulations (see p. 615), is not a safeguard, and even drying and condensing processes cannot always be relied upon to kill the bacilli. Striking evidence exists, however, to prove the efficacy of adequate pasteurisation in the protection of the population from tuberculosis of bovine origin. Beef is frequently infected, and the tuberculous material may get smeared over the flesh during dressing of the carcase, but it is not suggested that infected meat is a common cause of tuberculosis in human beings.

Measures of control. The first organised efforts to deal with tuberculosis were voluntary in character. Sir Robert Philip, of Edinburgh, elaborated his dispensary system in 1887, and the first dispensaries in England were opened in Paddington and St. Marylebone in 1909 and 1910. Here and there throughout the country tuberculosis had been made locally notifiable, but in 1908 regulations were issued requiring cases of pulmonary tuberculosis occurring in poor law practice to be notified. Other regulations followed, and in 1912 notification was extended to all forms of tuberculosis, whether occurring in public or in private practice. In 1911 "sanatorium benefit" was included as one of the benefits under National Health Insurance, but it was soon realised that any scheme dealing with tuberculosis should be made available for the whole com-

munity and not merely for insured persons. The Local Government Board urged county councils and county borough councils to provide the necessary facilities for diagnosis and treatment and promised a 50 per cent. net grant on all approved expenditure. This policy of the Board was given effect to in the Public Health (Prevention and Treatment of Disease) Act, 1913. In 1921 "sanatorium benefit" ceased to be a benefit under National Health Insurance, and the Public Health (Tuberculosis) Act, 1921, required all county and county borough councils to make adequate arrangements for tuberculous persons and gave them permission to assist in their "after-care."

In 1925, county councils and local authorities were given power to apply to court for an Order for the removal to an institution, in specified circumstances, of persons suffering from pulmonary tuberculosis, and by the Public Health (Prevention of Tuberculosis) Regulations, 1925, the employment of persons suffering from tuberculosis of the respiratory tract was prohibited in various branches of the milk trade. Finally all the earlier regulations dealing with notification, etc., were consolidated in the Public Health (Tuberculosis) Regulations, 1930, and the remainder of the legislation relating to tuberculosis in the Public Health Act, 1936 (see p. 560).

The Local Government Act, 1929, simplified the institutional care of tuberculous persons. Many cases had formerly received treatment in hospitals controlled by boards of guardians. These hospitals were handed over to county councils and county borough councils (the local authorities for tuberculosis schemes) and, in the case of such local authorities as have found it possible to treat all cases of tuberculosis under the Public Health Acts, dual control of the disease has ceased.

It should be noted that the information given to the M.O.H. by notification must be regarded as confidential, although exception is made in the case of infectious tuberculous persons employed or seeking employment in the milk trade.

The direct methods of attack are—the medical service, the dispensary, the residential institution, and after-care. It is of interest that the net cost of the Lancashire tuberculosis scheme—one of the most complete in this country—amounted to 2*s.* 2½*d.* per head of the population for the year ended 31st March, 1942. The estimated population in the administrative county of Lancashire was approximately 1,900,870.

(1) *The medical service.* The general practitioner is the person most likely to see the tuberculous patient in the earliest stages of the disease, and upon him lies the duty of notification. He, too, is responsible for the domiciliary treatment of cases. Notification is still far from satisfactory. Thus during 1942 in England 2,580 deaths were certified due to tuberculosis

in patients who had not been notified during life. Of these 1,647 were cases of pulmonary tuberculosis.

Mass radiography with miniature X-ray films is now very much employed. This method is economical and is rapid in detecting lesions prior to a more thorough X-ray examination. It should, however, be regarded as an investigation whose function is not so much diagnosis as the sifting from a number of apparently healthy persons those whose condition requires further individual diagnosis by established methods. (Min. of H. Memo, 266 T., 1943, and Advisory Report on the Working of a Mass Radiography Unit, 1943.) The results of the mass radiography of 75,000 cases in the Royal Air Force showed that 66, or approximately 28 per cent., of the so-called " fit " persons found to have active pulmonary tuberculosis had already reached the stage of cavity formation and out of these cases 32, or nearly 50 per cent., had positive sputum. (*B.M.J.*, 8th May, 1943, p. 565, Evans, A. G.) Experience in the United States has shown that about one in every hundred persons examined had significant tuberculosis of the lungs. Of these, between 55 and 60 per cent. were in the early stages most amenable to treatment, usually without sanatorium care. From 35 to 45 per cent. of the cases discovered were moderately advanced and only 3 to 4 per cent. far advanced.

With a view to securing diagnosis and treatment of pulmonary tuberculosis at the earliest possible stage and in order to help men and women for whom such treatment means an interruption of earnings or other income, the Government now provides financial assistance. This consists of (*a*) maintenance allowances based on a standard scale and without any test of means ; (*b*) discretionary allowances, on proof of need, towards meeting standing charges such as high rents or rates, insurance premiums, school fees, etc., where the patient would be unable to meet these liabilities, and (*c*) special payments to meet certain special circumstances. All assistance is paid through the local authorities for tuberculosis and the treatment must be that recommended by the tuberculosis officer.

The school medical officer is in a position to detect " suspects " and should refer these to the tuberculosis officer for observation, diagnosis, and, if necessary, treatment. The tuberculosis officer should receive all notifications of cases and deaths, his services should be readily available for all practitioners, and he should be in close touch with all agencies having an interest in tuberculous persons. There should be, generally speaking, one tuberculosis officer for every 150–200 deaths per annum from tuberculosis. Health visitors, nurses and clerical staff should be attached to the dispensary so that the tuberculosis officer may spend as much of his time as possible in strictly medical work. It is the duty of the medical officer of health to

see that the special machinery for dealing with tuberculosis is properly correlated with the general work of preventive medicine. (For qualifications of tuberculosis officers and nurses, see p. 14.)

(2) *The dispensary.* The six functions of a dispensary are—

(1) Receiving-house and centre for diagnosis.
(2) Clearing-house and centre for observation.
(3) Centre for curative treatment and supervision of domiciliary cases.
(4) Centre for examination of contacts.
(5) Centre for "after-care."
(6) Information bureau and educational centre.

One dispensary is necessary for every 150,000–200,000 persons. The dispensary organisation should include a pathological laboratory, an X-ray department and some arrangement for referring to experts difficult cases for differential diagnosis.

All definite cases of tuberculosis should be referred for domiciliary treatment to their own medical attendants, except (*a*) those requiring immediate residential treatment in institutions; (*b*) those requiring some special treatment which can best be given in connection with a dispensary; and (*c*) non-insured persons who cannot afford to call in a private practitioner. The Minister of Health holds the view that the time required for diagnosis of a case should as a rule not exceed one month.

Examination of contacts is regarded as one of the best methods of detecting those early cases which respond most favourably to treatment. Jessel (*Tubercle*, Vol. 2, 1930, pp. 493–500) advised that, as the average interval between the discovery of the primary and the secondary cases is three and a half years, contacts should be kept under observation for at least four years. For every 100 new cases found to be tuberculous in 1938 in England and Wales, 144 contacts were examined, and in the same year one out of every seventeen cases of pulmonary tuberculosis among adults was discovered as a result of contact examination—7·9 per cent. of the men contacts and 6·0 of the women contacts examined were found to be tuberculous. The disparity in the number of adult male and female contacts examined in the same year—9,840 adult male and 16,276 adult female—is unsatisfactory in view of the higher incidence of pulmonary tuberculosis in males, but this is probably due to the difficulty of arranging for the examination of men who are at work during the day. A careful investigation of selected contacts is more valuable than a perfunctory examination of a large number. The selection should include (*a*) any members of the family not in normal health, (*b*) all adolescents and young adults, (*c*) the consort of a wife or husband with tuberculosis, and (*d*) those who have been in

close contact with an infectious case. (*Public Health*, January, 1940, pp. 78–82, "The Tuberculosis Dispensary," Jessel, G.)

(3) *Residential institutions.* On 31st December, 1942, the number of beds provided for tuberculosis by local authorities in England was 20,075 and by voluntary organisations 5,415.

ENGLAND AND WALES: TABLE SHOWING THE WORK DONE BY THE DISPENSARY SERVICE DURING 1934–38.

——	1934.	1935.	1936.	1937.	1938.
1. New cases examined for the first time	101,929	100,546	106,367	110,809	114,334
2. Contacts ,, ,, ,,	50,561	48,392	48,857	50,573	54,729
Total	152,490	148,938	155,224	161,382	169,063
3. New cases and contacts diagnosed to be tuberculous:					
Pulmonary: Adults	31,578	29,636	29,578	29,868	29,045
,, Children	3,422	2,839	2,677	2,321	2,379
Non-pulmonary: Adults	4,136	4,131	3,892	4,360	4,319
,, Children	5,462	5,131	4,923	4,881	4,999
Total	44,598	41,737	41,070	41,430	40,742
4. Contacts diagnosed to be tuberculous	3,450	2,998	2,851	2,705	2,730
5. Removed from Dispensary Registers as:—					
Non-tuberculous	108,425	107,497	113,626	119,139	127,736
Recovered	14,937	13,831	13,777	13,266	12,585
Dead (all causes)	21,623	21,268	20,536	21,032	19,670
6. "Recovered" cases restored to registers *	576	592	576	607	566
7. Cases on Dispensary Registers on 31st December					
Pulmonary: Adults	124,873	123,415	122,798	122,135	122,621
,, Children	21,261	19,520	18,226	16,622	15,862
Non-pulmonary: Adults	23,040	22,822	22,513	22,801	23,193
,, Children	30,527	29,516	28,317	26,977	26,580
Diagnosis not yet completed: { Adults / Children }	12,549	11,857	11,717	12,499	12,402
	212,250	207,130	203,571	201,034	200,658
8. Pulmonary cases on Registers which were T.B. + . .	68,491	69,070	70,069	71,023	71,997
9. Consultations: personal . .	22,592	22,971	23,108	24,107	25,627
other . . .	130,296	132,372	143,183	153,488	166,954
Total	152,888	155,343	166,291	177,595	192,581
10. Sputum examinations . .	119,516	119,243	129,378	131,443	131,362
11. X-ray examinations . . .	104,084	120,420	144,826	162,018	195,232
12. Home visits by Tuberculosis Officers (including personal consultations) .	89,201	87,883	87,968	88,002	90,682
13. Home visits by Nurses or Health Visitors	823,685	804,635	800,680	802,376	791,357
14. Attendances at dispensaries . .	839,118	813,338	824,545	821,183	851,470

* Included in 1 and 3.

Residential treatment includes treatment in sanatoria, hospitals and village settlements. There should be in an area approximately one bed per death from tuberculosis per annum (exclusive of deaths in mental hospitals), although this figure may be altered at times owing to special local conditions. The proportion of beds should be 75 for pulmonary to 25 for non-pulmonary cases.

(1) *Sanatoria.* The distinction between "sanatorium" and

"hospital" is much less marked than formerly. Sanatorium treatment as now understood does not consist of "fresh-air" treatment alone, although the basis of controlled rest, exercise, diet and fresh air remains. All modern methods of diagnosis must be available, such as those of the laboratory and the X-ray department, and there must also be facilities for the practice of collapse therapy (artificial pneumothorax, phrenic nerve operations and even thoracoplasty).

It is probable that the optimum size of a sanatorium is 250 beds (see p. 211). The medical staff of a sanatorium of this size should be medical superintendent, deputy medical superintendent, and three assistant medical officers, of whom at least one should have special experience of laboratory work. A consulting staff should also be available. (See Memo. on "Cost of Hospitals and other Institutions," *Public Health*, October, 1934; Report of Joint Tuberculosis Council on "The Utilisation of Residential Institutions for Tuberculosis," 1934.)

Most sanatoria now provide some form of occupational therapy for patients who have become afebrile. Occupational therapy may be defined as "any activity mental or physical definitely prescribed or guided for the distinct purpose of contributing to and hastening recovery from disease or injury." Gardening, clerical work, basket-making, weaving, leather and raffia work, boot repairing, carpentry, poultry farming are occupations with which various sanatoria have experimented. A small bonus is paid to patients so employed—this does not interfere with their rights to sickness or disablement benefit under National Health Insurance.

Cases must be carefully selected for admission, and waiting lists must be frequently examined in order that patients in urgent need of treatment and those considered to be dangerous sources of infection should be removed to the sanatorium as soon as possible.

Results of sanatorium treatment. In the Min. of Health Memo. 37/T, 1930 (revised), a case is defined as "quiescent" which has no symptoms of tuberculous disease, except such as are compatible with a completely healed lesion and in which the sputum, if present, is free from tubercle bacilli. An "arrested" case is one in which, if pulmonary, the disease has been quiescent for at least two years, or, if non-pulmonary, the disease is "quiescent" and is unlikely to recur. No "arrested" case should be discharged as "recovered" (or "cured") until arrest of the disease has been maintained for three years after the period of two years' quiescence.

Immediate results depend on the stage of the disease at which the patient is admitted, the presence or absence of tubercle bacilli in the sputum, and the length of stay in the sanatorium.

The following tables were extracted from the Annual Report of the C.M.O., Ministry of Health, 1936 :—

ENGLAND: IMMEDIATE RESULTS OF TREATMENT DURING 1936 IN PUBLIC HEALTH HOSPITALS AND APPROVED SANATORIA OF ADULTS SUFFERING FROM PULMONARY TUBERCULOSIS WHO WERE TREATED FOR PERIODS EXCEEDING TWENTY-EIGHT DAYS.

Stage of Disease on admission.	Number discharged.	Condition on discharge.				Disease not quiescent.
		Disease quiescent.		Died in institutions.		
		Number.	Per cent.	Number.	Per cent.	
T.B. — . .	6,591	3,079	47	341	5	3,171
T.B. + 1 . .	2,600	853	33	158	6	1,589
T.B. + 2 . .	12,928	1,654	13	1,197	9	10,077
T.B. + 3 . .	7,397	270	4	3,200	43	3,927
All stages .	29,516	5,856	20	4,896	17	18,764

ENGLAND: NUMBER OF ADULT PATIENTS SUFFERING FROM PULMONARY TUBERCULOSIS AND PERCENTAGE OF THE TOTAL ADMITTED IN EACH GROUP WHO REMAINED FOR PERIODS EXCEEDING SIX MONTHS.

Classification on admission.	1934		1935		1936	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
T.B. — . . .	1,355	20·2	1,381	21·0	1,475	22·4
T.B. + Group I. .	964	35·8	973	36·6	1,073	41·3
T.B. + Group II.	4,629	36·7	4,965	39·3	5,135	39·7
T.B. + Group III.	2,204	29·6	2,220	31·0	2,298	31·1
All stages . .	9,152	31·1	9,539	32·8	9,981	33·8

Group I. = incipient cases, Group II. = moderately advanced cases, Group III. = far advanced cases.

Ultimate results depend on the condition of the patient on admission, age and sex (females with early disease appear to obtain better ultimate results than males, whereas they obtain rather worse results if the disease is more advanced), presence or absence of bacilli in the sputum especially on discharge, quiescence of disease on discharge and the economic status of the patient.

The following table shows the percentage of adult patients discharged from L.C.C. hospitals and sanatoria in 1931 who were alive five years later. The corresponding figures for 1930 are shown in brackets.

Classification.	Total.	Percentage alive five years after discharge.	Percentage dead.
T.B. —	517 (481)	77·2 (74·8)	22·8 (25·2)
T.B. + Group I.	162 (126)	77·8 (71·4)	22·2 (28·6)
T.B. + Group II.	1,704 (1,866)	41·1 (34·7)	58·9 (65·3)
T.B. + Group III.	830 (889)	7·8 (6·7)	92·2 (93·3)
Non-pulmonary	257 (272)	74·1 (76·8)	25·9 (23·2)

Of the 1,479 surviving adult patients who were discharged in 1931, 59·5 per cent. were at work in 1936, 5·0 per cent. were fit but unemployed and 28·1 per cent. were unable to work. Of the T.B. — and T.B. + Group I cases, 68·4 per cent. were at work, and of the T.B. + Group III cases, 40·0 per cent. Of 3,446 adult patients with pulmonary tuberculosis discharged in 1933, only 43 per cent. were alive five years later.

In the "Brompton Hospital Reports," Vol. IV., 1935, an analysis is made of 8,766 cases treated at Frimley Sanatorium during the years 1905–1931. The conclusions reached are that the mortality experienced depends almost entirely on the classified stage of the disease on admission, and is relatively unaffected by sex or age. The probability of survival improves year by year after the first two years, and is materially increased in the case of patients submitted to treatment by artificial pneumothorax. In the majority of cases of pulmonary tuberculosis there is a symptomless stage during which all too frequently patients with early disease fail to seek advice.

(2) *Hospitals.* In the past there has been a tendency to regard hospitals as places for the reception of cases not considered suitable for sanatorium treatment. Modern experience favours the establishment of a single institution which is really a sanatorium-hospital or treatment centre. In such an institution acute cases, chronic cases and early observation cases should be about equally divided. If, however, a hospital, as distinct from a sanatorium, exists in an area, it should be used for cases requiring observation for diagnosis as well as for definite cases of tuberculosis.

Special accommodation in local authorities' institutions is needed for (*a*) advanced pyrexial cases, more or less bedridden, and (*b*) cases such as mental defectives, homeless persons, and "difficult subjects" requiring a certain amount of discipline.

(3) *Accommodation for children up to 15 years.* Children with positive sputum should be treated in institutions adjoining those for adults; children with negative or no sputum are best dealt with in sanatorium schools; while "pre-tuberculous" children should attend open-air schools (see p. 298).

(4) *Institutions for cases of non-pulmonary tuberculosis.* In

Lancashire it has been found necessary to provide one bed per 2,109 of the child population for children, and for adults one bed per 9,943 of the adult population. In cases of combined surgical and pulmonary tuberculosis the pulmonary condition is usually predominant. Specialist surgical advice should be available.

Care and after-care schemes include " all measures, other than those which are purely medical, which are regarded as desirable for the welfare of the tuberculous patient." The social and economic interests of the family must be looked after, both while the patient is under treatment and after he is discharged fit to return to work. The replacing of the ex-tuberculous patient in employment is one of the most difficult administrative problems. (Min. of H. Circular 2526, Nov., 1941; Report of Joint Tuberculosis Council on " Care and After-Care Schemes in Tuberculosis," 1941.)

(1) *Care and after-care committees*. These committees, where they exist, usually include representatives of such bodies as the Invalid Children's Aid Association, School Care Committees, local War Pensions Committee, District Nursing Association, local Insurance Committee, etc., together with members of the county or county borough council. The tuberculosis officer must guide the committees in all their work. Their duties are connected with propaganda, home visiting, the giving of financial and other material assistance, provision of convalescent home treatment for children of the family when advised by the tuberculosis officer, and help to the ex-patient in finding suitable employment. Few committees have adequate funds at their disposal. The local authority may aid by providing office accommodation and clerical help, and by making contributions to the care funds. An excellent account of care work is given in the Report of the Central Tuberculosis Officer of the Lancashire County Council, 1936, pp. 125–130.

(2) *Employment of ex-tuberculous patients*. It is estimated that between 40 and 50 per cent. of patients discharged from sanatoria as fit to return to work resume their previous occupations. It is useless as a rule to advise a man trained in one form of work to try something else. Most industries need either men highly skilled in some process or else men possessing definite physical fitness. A small number of men get work in some sheltered position under a local authority, *e.g.* park attendants. Women are frequently employed on sanatorium staffs as nurses or maids. There is, of course, the risk of breakdown in such cases, and it has been suggested that, if 25 per cent. of the sanatorium staff were ex-patients, there would have to be a margin of 7–12 per cent. of staff to meet such risk. Various municipal workshops have been opened to give employment to ex-patients, such as the Factory in the Fields in Leeds,

and the Spero Workshops in London, but such undertakings are likely to be run at a considerable loss. They are useful, however, as a step towards restoring health and working capacity.

(3) *Village settlements*—(notably Papworth and Preston Hall). A settlement consists of three units—the hospital-sanatorium, the industries and the estate on which are the houses occupied by the settlers. Patients are admitted in the ordinary way to the sanatorium and occupational therapy is prescribed for them in one of the industries. In this way the patient mixes with men who have become self-supporting in the industries and the psychological effect is marked. The industries are run by ex-patients, although certain key positions are usually occupied by healthy men. Once a patient is fit to take his place in one of the industries and is regarded as suitable for admission as a settler, he is, if single, given accommodation in a hostel, or, if married, he is provided with a house and allowed to bring his family. Such settlers receive trade union rates of wages and they themselves pay for the accommodation they obtain. They have security of tenure and are not thrown out of employment when trade is slack. The chief industries are carpentry and joinery, building, cabinet-making and upholstery, manufacture of leather and fibre travelling goods, printing, etc. The standard of efficiency demanded must of necessity be high as the industries must be self-supporting. Village settlements are costly—at Preston Hall the estimated capital expenditure on industries is about £125 per settler and, if a house has to be provided for him, another £400 must be added. It must, however, be mentioned that a local authority might have had to provide a house for such a patient in his own area. Then the settlement caters for the very few, for it will never be possible to create large numbers of such institutions. Thus the total staff of ex-patients on the wages and salary list at Preston Hall in May, 1943, was 210, the number of settlers 174, while the total number of settlers in the three largest settlements in the country is less than 500. There is a tendency to retain settlers rather too long ; those who have shown no symptoms for years and appear fit to take their places in ordinary industry should make room for others for whom the more sheltered life is necessary.

These settlements, however, represent a really constructive effort to deal with the after-care of tuberculous persons, and their development is being watched with the greatest interest.

Nayland Sanatorium, near Colchester, was taken over by the British Legion on 1st May, 1943, with the object of providing treatment for cases of pulmonary tuberculosis among women discharged from the Navy, Army or Air Force, and of

placing the same facilities in the way of these ex-service women at Nayland as the Legion has done for ex-service men at Preston Hall. The sanatorium, which has provided tuberculosis treatment for many years, is now under the same directorate as Preston Hall and there is every reason to believe that the industrial side will develop along the same lines. The total accommodation for women will ultimately be in the neighbourhood of 200 beds.

Tuberculin and B.C.G. Although tuberculin in one or other form has still some advocates for its use in treatment, it is mainly employed as a diagnostic agent, especially in children. The intracutaneous test of Mantoux is usually performed by the injection into the skin of 0·1 c.c. of graded dilutions of old tuberculin, beginning with 1 in 10,000. Redness and œdema within a few hours indicate a positive reaction. Old tuberculin consists of a concentrated filtrate of a glycerine veal broth on the surface of which tubercle bacilli have been grown.

The tuberculin patch test (Vollmer) may be used instead of the Mantoux test, though there is some difference of opinion as regards its reliability, especially in the case of adults. Small squares (1 × 1 cm.) of thin filter paper saturated with undiluted tuberculin are fixed on adhesive tape and applied to a cleansed area of the sternum; a control saturated with glycerine broth is also applied. After 48 hours the patches are removed. The reaction may appear immediately but, as it is frequently delayed, the test should not be read till 48–72 hours after removal. An area of erythema (10 mm. in diameter) may be regarded as a positive reaction. The patch test is preferred by many in the case of children as it is considered reasonably accurate and the use of a needle is avoided.

B.C.G. (*Bacille Calmette-Guérin*) is a strain of *Myco. tuberculosis* attenuated by years of artificial cultivation. These avirulent bacilli are used for the prevention of tuberculosis, the method adopted by Calmette being that of oral administration to new-born infants. Both in France and elsewhere large numbers of infants have been so treated. There is some evidence that B.C.G. vaccination, parenteral or by mouth, does increase resistance to tuberculosis, but it is doubtful whether its use could be justified save in the case of those specially exposed to infection such as nurses or medical students, or infants born into tuberculous families. (An excellent review of the administrative aspects of tuberculosis will be found in Ministry of Health Report No. 64, 1932, MacNalty, A. S.; and in the Quarterly Bulletin of the Health Section, League of Nations, Vol. I., No. 4, 1932, Burnet, E., and a useful "Report of the Committee of Inquiry into the Anti-tuberculosis Service in Wales and Monmouthshire" was issued by the Ministry of

Health in 1939. See also Public Health, June, 1941, pp. 158–63, "Co-ordination and Regionalisation of Tuberculosis Services in England, Wales and Scotland," Lissant Cox, G. The control of tuberculosis in the tropics is dealt with in the Tropical Diseases Bulletins, Vol. 34, No. 11, November, 1937, pp. 819–836, Cochrane, and Vol. 35, No. 9, September, 1938, pp. 629–640, Wilcocks.)

Rheumatism may be classified into three main groups :—

(*a*) Acute rheumatism (rheumatic fever), together with subacute rheumatism.
(*b*) Non-articular manifestations (fibrositis, neuritis).
(*c*) Diseases characterised by chronic joint change.

Acute rheumatism is now considered by many to be a specific infectious disease possibly conveyed by droplet infection, but compared with other diseases of this nature its infectivity is of a low order. While cases are usually sporadic, from time to time small outbreaks of rheumatic fever occur. The attack is often preceded by tonsilitis which may be mild. One attack affords no immunity and there is liability, particularly in children, to progressively severe recurrences.

Valvular disease of the heart, chorea, tonsilitis and certain skin conditions may also be the result of acute rheumatism in childhood and adolescence. (Ministry of Health Report, No. 44, 1927, "Acute Rheumatism in Children in its Relation to Heart Disease.") It is these manifestations of rheumatic infection that make the disease so formidable. The incidence and mortality fall most heavily upon children between five and fourteen years of age, and it is probable that at least nine-tenths of the deaths at ages under fifteen from heart disease may be attributed to acute rheumatic infection. It is of interest that during recent years there has been a notable decline in the incidence of acute rheumatism in children.

Female insured workers suffer more than males from acute and subacute rheumatism, rheumatoid arthritis, osteo-arthritis and brachial neuritis. Male insured workers show a higher incidence of lumbago, gout and sciatica. Endocarditis occurs more frequently in females.

There is a large body of evidence showing that there is a significant association between acute rheumatism and infection with hæmolytic streptococci though the exact nature of the association is difficult to determine. Tonsilitis and scarlet fever have long been considered to be predisposing factors. Social conditions play an important part in promoting rheumatism and it has been shown that acute rheumatism occurs twenty to thirty times as frequently among the poor children of an industrial town as among children of the well-to-do. Its incidence increases directly with malnutrition, overcrowding

and bad housing. ("Control of the Common Fevers," pp. 125–38, "Rheumatic Fever," Glover, J. A., Lancet Ltd., 1942; *Lancet*, 18th July, 1942, p. 59, Morris, J. N., and Titmuss, R. M.) The Medical Research Council Report No. 114, 1927, showed that the maternal care was inferior, the amount of exposure greater, and the clothing less adequate among the rheumatic group than among the controls. Illness was also commoner among the parents of rheumatic children. Excess of starch and lack of fat in the diet have been blamed by some workers and various vitamin deficiencies have been held responsible by others. Schlesinger has pointed out that most of these factors can be related to unhygienic home surroundings in which the mother is often unable to devote enough time to each member of a large family. Holidays in the country are short and in many cases quite out of the question, so that minor catarrhal infections or acute illnesses are apt to become protracted. Economic considerations are generally to blame, and there is often actual poverty. There is no doubt that these circumstances have a bad effect on the general health of the child population of the large cities and there is some evidence to show that rheumatism flourishes under such conditions. (*Lancet*, 19th March, 1938, pp. 649–654; J. Am. Med. Assoc., 27th March, 1943, p. 991, Ditkowsky, S. P., Stevenson, E., and Campbell, J. M.)

The problem of "rheumatism" in industrial workers is one of great magnitude. In a sample of the insured population it was found that in 1922 the attack rate was 30·5 per 1,000 males and 22·5 per 1,000 females. In every 1,000 insured males there were during the year one case of rheumatic fever, three cases of subacute rheumatism, three of sciatica, six of muscular rheumatism and ten of lumbago, together with one of rheumatoid arthritis and three of osteo-arthritis. In every 1,000 insured females there were two cases of rheumatic fever, three cases of subacute rheumatism, one of sciatica or brachial neuritis, seven of muscular rheumatism and only three of lumbago, together with three cases of rheumatoid arthritis and two of osteo-arthritis. "Rheumatic" diseases cause almost exactly one-sixth of the total sick absence due to all diseases among insured males, nearly one-third of the rheumatic sick absence being due to non-articular rheumatism and only one-seventh to acute and subacute rheumatism. Efforts are being made by the British Red Cross Society, local authorities and other institutions to provide means of early diagnosis and treatment for these disabling conditions (see also p. 297).

("The Incidence of Rheumatic Disease," Ministry of Health Report, No. 23, 1924; *Lancet*, 30th April, 1932, p. 967, "Control of Industrial Rheumatism," Copeman; *J. Roy. San. Inst.*, November, 1938, pp. 349–376, Report of a Conference on

Rheumatism; "Rheumatism—A Plan for National Action," Horder, Lewis & Co. Ltd., 1941).

Venereal diseases include syphilis, gonorrhœa, soft chancre, lymphogranuloma inguinale or venereum (lymphopathia, venereum, poradenitis venerea), granuloma venereum, a form of balanitis due to the organisms responsible for Vincent's angina which is sometimes called the fourth venereal disease, and Waelsch or sago-grain urethritis, but of all these only the first three are recognised in the Venereal Diseases Schemes operating in Great Britain and Northern Ireland. The Royal Commission on Venereal Diseases (1913–16) stated that "the number of persons who have been infected with syphilis, acquired or congenital, cannot fall below 10 per cent. of the whole population in the large cities, and the percentage affected with gonorrhœa must greatly exceed this proportion." As will be shown, this incidence has become greatly reduced. These diseases are responsible not only for a large percentage of mental and physical defects among the actual sufferers, but also for a large proportion of children either born dead or dying in early infancy. The Registrar-General classes tabes dorsalis, general paralysis of the insane and aneurysm as diseases of syphilitic origin.

The control of venereal disease has always been a matter of great difficulty. Between 1864 and 1882 under the Contagious Diseases Acts prostitutes in certain garrison towns in this country could be examined and, if diseased, ordered to be treated in hospital. Furthermore, periodical inspection of such persons was instituted. These measures proved of little avail, and the Acts were repealed in 1886. Recognised prostitutes are only one, and probably not the main, source of infection; hence other measures of control must be sought.

The prevalent opinion in this country is that the best results are likely to be obtained from encouraging young adults to lead clean, healthy lives, and from providing centres for the expert diagnosis and early treatment of venereal disease should it be contracted. Arising out of the recommendations of the Royal Commission, the Public Health (Venereal Diseases) Regulations, 1916, were issued. These Regulations required the councils of counties and county boroughs to make arrangements for providing any practitioner with scientific reports on material from patients suspected to be suffering from venereal disease; for the treatment at or in hospitals or other institutions of cases of venereal disease; and for supplying medical practitioners with approved arsenobenzene compounds. Until the end of March, 1930, local authorities were repaid 75 per cent. of the cost of all approved schemes by Exchequer grants. After this date such grants were included in the block grants paid to

local authorities towards the costs of their various grant-aided services. At the end of 1940 the Government agreed to repay to local authorities 75 per cent. of the expenditure incurred in expanding their services to meet the increased danger of the spread of these diseases which had been brought about by war conditions. An essential condition of such schemes is that all information concerning persons treated must be regarded as confidential. Thus every case of suspected or actual venereal disease can be diagnosed and if necessary treated confidentially and at no cost to the patient. It should be remembered that venereal disease officers and pathologists must possess the training and experience required by the Local Government (Qualifications of Medical Officers and Health Visitors) Regulations, 1930, and 1933 (see p. 14). Clinics are held at hours most likely to suit the convenience of patients and every endeavour is made to secure as much privacy as possible for those attending. The institution of special venereal disease clinics in connection with maternity and child welfare centres is to be commended, as is also systematic instruction of nurses and midwives in the chief signs of the disease and their effects. In addition to treatment centres, arrangements have been made with a number of practitioners possessing certain qualifications for the treatment of cases of venereal disease in their own surgeries at the cost of the public. This service, which is primarily for the rural areas, is intended to be under the supervision, in each county, of a county consultant. Local authorities may repay reasonable travelling expenses if the M.O.H. is satisfied that without such help the patient could not receive the necessary treatment.

Official measures would prove of little avail if unqualified persons were at liberty to practise the treatment of venereal disease ; hence in 1917 the Venereal Disease Act was passed. This Act prohibits, under penalty, any but qualified medical practitioners from treating such diseases in any area to which this Section of the Act may be applied by order of the Minister of Health, *i.e.*, any area which has in operation an approved treatment scheme. In addition, all advertisements by other than local authorities offering treatment for such diseases are forbidden, and no label may be affixed to any preparation sold to the non-medical public stating that it will prevent or cure venereal disease. Under the Brussels Agreement of 1924 merchant seamen of any nationality may receive treatment free of charge at any of the treatment centres of the signatory Governments.

The following table shows the number of persons dealt with for the first time at the venereal disease treatment centres in England and Wales in various years since the inception of the Venereal Disease Scheme :—

Year.	Number of persons dealt with for the first time.*						Total Number of Attendances.	Number of Treatment Centres at end of year.
	Syphilis.	Soft Chancre.	Gonorrhœa	Total V.D.	Other than V.D.	Total.		
1917	—	—	—	—	—	29,036	204,692	113
1918	26,912	806	17,635	45,353	6,622	51,975	488,137	134
1919	42,134	2,164	38,499	82,797	15,447	98,244	1,002,791	160
1920	42,805	2,442	40,284	85,531	19,654	105,185	1,488,514	190
1921	32,733	1,654	32,433	66,820	17,459	84,279	1,612,592	194
1922	25,762	1,108	29,477	56,347	16,988	73,335	1,560,568	191
1927	23,395	1,063	38,242	62,700	25,436	88,136	2,179,707	186
1932	22,215	952	41,251	64,418	32,997	97,415	3,109,174	188
1937	19,185	941	43,802	63,928	38,591	102,519	3,342,571	186
1938	18,034	1,007	41,759	60,800	41,487	102,287	3,119,331	187
1939	16,950	943	35,851	53,744	39,302	93,046	2,310,566	190

* The figures in this table include old as well as new infections, cases transferred from centre to centre and those that returned after being struck off the books in previous years; they are not therefore a reliable index of new infections in any year. New infections with syphilis numbered 8,728 in 1932 and 4,986 in 1939.

About 18 per cent. of males and of females with syphilis and 26 per cent. of males and 22 per cent. of females with gonorrhœa discontinued attendance during 1939 before being discharged from the centres as cured. These percentages are considerably lower than those of 1927.

Attendances of patients with gonorrhœa have become greatly reduced as a result of treatment with sulphonamides. As these drugs render the great majority of patients non-infectious in a few days, they have reduced considerably the significance, so far as the spread of gonorrhœa is concerned, of premature discontinuance of attendance.

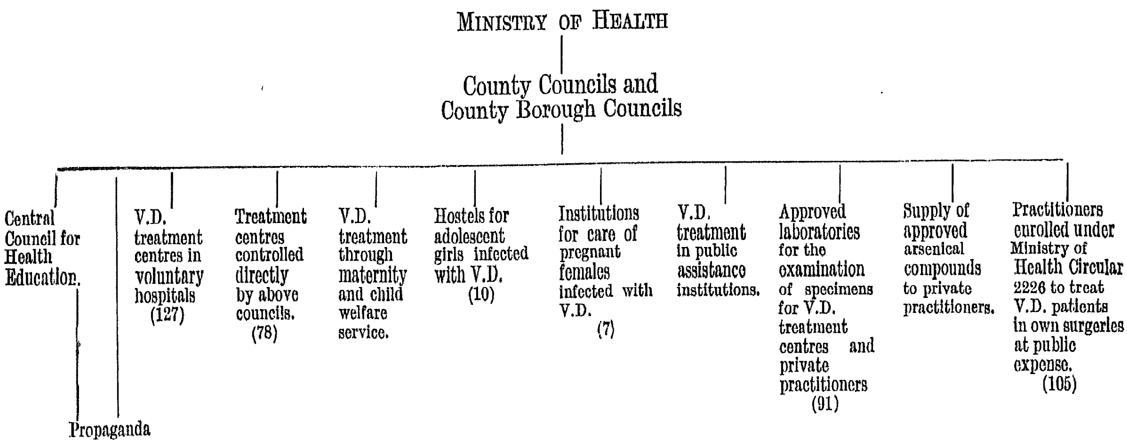
Prophylaxis by disinfection is employed in the British Army and the Royal Air Force, and is particularly applicable to service abroad where conditions render the soldier more liable to exposure. In the Army, facilities are available at the preventive ablution rooms in barracks for irrigation or cleansing with 1 in 6,000 permanganate of potash. Irrigation has of late years fallen into disfavour; cleansing with soap and water and permanganate is sometimes preferred. The treatment concludes with a thorough inunction with calomel ointment. At the ablution room the soldier can provide himself with a preventive packet which contains an ointment made of approximately 25 per cent. calomel, 0·075 per cent. cyanide of mercury, 35 per cent. each of lanoline and vaseline, and 5 per cent. vegetable wax. Men are advised to use the contents of the packet before as well as after exposure. Some Army units, under their own arrangements, provide condoms, and these are preferred by the Royal Navy.

In the Scandinavian and many other countries cases of venereal disease must be notified and patients are required to undergo treatment. Health authorities have power to enforce

treatment, including hospitalisation if necessary. Power is also given to search for and bring under control all sources of infection and all defaulting patients. While persuasion is usually sufficient, coercive measures may be exercised. The Swedish laws, which are fully described in the Ministry of Health Special Report No. 88, 1938, are frequently used as a model by countries introducing compulsory treatment of venereal diseases. In Great Britain, on the other hand, the diseases are not notifiable. In the Ministry of Health Report just mentioned the conclusion is reached that "considering that in the countries employing compulsory treatment and in those which rely on a voluntary system the degrees of success in reducing the incidence of syphilis and of relative failure in gonorrhœa are broadly similar, compulsory treatment does not seem to us to be a major factor influencing the results of the anti-venereal measures in the countries where it is employed." A modified measure of compulsion (Regulation 33B) was, however, instituted in 1942. This Regulation enables a county or county borough M.O.H. to require a person who has been alleged by two other persons to have been a source of infection to submit to examination and, if necessary, treatment.

In the Annual Report of the C.M.O., Ministry of Health, 1938, it was shown that the number of early infections with syphilis dealt with for the first time by the treatment centres in England and Wales in 1938 was over 42 per cent. less than in 1931, the year in which figures relating to infections of less than a year's duration were first separately recorded. In the following year the figures showed a still further decline to 4,986 (males 3,574, females 1,412), or more than 45 per cent. less than in 1931. There is good evidence for the belief that the overwhelming majority of the early cases of syphilis which come under medical care in Great Britain are dealt with in the treatment centres and the number so dealt with in the centres in England and Wales in 1939 represented 1·21 per 10,000 of the population. In males the ratio of primary to secondary cases of syphilis dealt with for the first time in such centres in the five years 1932 to 1936 was 1 : 0·45. This is evidence of the tendency to seek early advice. In the British Army (both at home and abroad) the rate of syphilis per 1,000 fell from 15·8 in 1913 to 2·7 in 1936. Even more remarkable was the decline in syphilis in the troops stationed at home, viz., from 19·2 per 1,000 per annum in 1913 to 1·0 in 1936 and 0·9 in 1937. As further evidence of the decline in syphilis the following may be mentioned: The percentage of expectant and nursing mothers attending ante-natal centres whose blood showed a positive reaction fell in Battersea from 3·5 in 1924 to 0·1 in 1938, in Cardiff from 3·1 in 1928 to 0·9 in 1938 and in Glasgow from 4·9 in 1925 to 1·8 in 1935. In contrast to this, in Special Report No. 82 of the

CHAIN OF RESPONSIBILITY IN ENGLAND AND WALES



Figures relate to position on 31/12/1942.

VENEREAL DISEASE.

M.R.C., 1924, Cruickshank showed that 1,881 unselected mothers in Glasgow gave positive blood tests in 9·04 per cent. of cases (8·91 per cent. in the married and 11·16 in the unmarried). Deaths of infants under one year in England and Wales certified as due to syphilis were at the rate of 0·2 per 1,000 live births in 1939 as compared with 1·46 in 1913 and 1·05 in 1923. In 1931 the cases of congenital syphilis dealt with for the first time at treatment centres numbered 2,439, and in 1939 they were 1,614. Of these 1,614 cases, 342 were under five years, 406 over five and under fifteen and 866 over fifteen years. Many of the cases over five were found to be suffering from interstitial keratitis, a disability which should have been prevented by early treatment. It is unfortunate that a large number of the mothers treated for syphilis during pregnancy fail to bring their infants later on for examination and treatment. Standardised mortality per million living from syphilis and from diseases of syphilitic origin fell in England and Wales from 225 in 1911–20 to 109 in 1938 (males), and from 79 to 42 (females).

The prevalence of gonorrhœa is difficult, if not impossible, to estimate from the numbers of cases dealt with at the treatment centres as it is believed that an important proportion of the infected resort to private practitioners or treat themselves, though it may be noted that in the five years 1935–39, inclusive, the ratio of male cases of early syphilis to male cases of gonorrhœa dealt with at the centres (1 to 7) was not much lower than the similar ratio in the Army stationed at home ; the ratio in females was 1 to 4·7. In the last two or three years the centres' figures have become less reliable owing to increase in resort to private practitioners, following simplification of the treatment of the disease by the introduction of the sulphonamide group of remedies.

Under war conditions the incidence of venereal disease in Great Britain has greatly increased, and in 1942 was more than double that in 1939. Such an increase is an invariable effect of war, and in this country has been favoured by the multitudes of homeless visitors of many nationalities.

Ophthalmia neonatorum and vulvo-vaginitis, in both of which gonococci may be the causal agent, are referred to on pp. 260 and 262.

Since October, 1942, the ban on the public discussion in this country of venereal diseases has been removed and the problem of their prevention and treatment is dealt with freely both in the Press and by broadcasting. Evidence is accumulating that the public would readily accept, in relation to these diseases, some of the measures of control used for the notifiable infectious diseases. There is much to be said for the introduction of a system of notification for all cases of congenital syphilis and for a great extension of social work in connection

with venereal disease clinics. Sources of infection should be ascertained and every attempt made to bring infected persons under treatment. An extension of social work by skilled officers is urgently needed. More serum tests for syphilis should also be done as a routine in ante-natal clinics.

It is of interest that notification, followed by some degree of compulsion in respect of treatment, is the accepted policy in almost every civilised country except our own.

Organisation of a venereal disease centre

A centre should attract the maximum number of patients and should be open all day until a late hour each evening for both consultation and intermediate treatment. If this is not possible, intermediate treatment should be available at all hours every day. Waiting should be reduced to a minimum and unnecessary exposure avoided. The centre should be arranged to allow for the routine treatment of gonorrhœa of both sexes. Surgical and medical equipment may be grouped into three sections, (1) for taking specimens, (2) for special examinations and the treatment of gonorrhœa, and (3) for the treatment of syphilis. Instrument tables on castors are useful as they can be moved from place to place.

The chief aim of a centre is to render patients non-infective as quickly as possible. Experience has shown that by far the best results are obtained if medical officers are employed whose first interest is in venereal disease and who have constantly in mind the public health object of the centre.

The plan shown in Fig. 1, p. 102, is one which ensures efficiency and is so arranged that the whole clinic can be kept under supervision. Owing to the sulphonamide treatment of gonorrhea probably fewer cubicles are now necessary for most clinics than are shown in this plan. This applies particularly to the irrigation cubicles. The principles of the arrangement, however, remain the same. The plan shows a waiting room A, adjoining office B, and consulting room C, rooms for special examinations D and E, cubicles for first examination and treatment F, G, H, and cubicles for irrigation of males J, K, L, M, which open on to a service room N.

Each cubicle is closed on three sides by a 7-feet high partition, and on the fourth side (opening on to the service room) by a curtain. There is an upholstered counter 2 feet 10 inches high and 1 foot 10 inches broad just behind the curtain. The medical officer obtains access to the cubicles from the service room by raising a flap in the counter. Each cubicle is furnished with writing table, instrument table, portable wash-hand stand and rack for urine glasses, and if females are treated at the clinic a gynæcological examination chair is also required.

Patients make use of the corridor O, and in this way do not

PLAN OF A V.D. TREATMENT CENTRE.

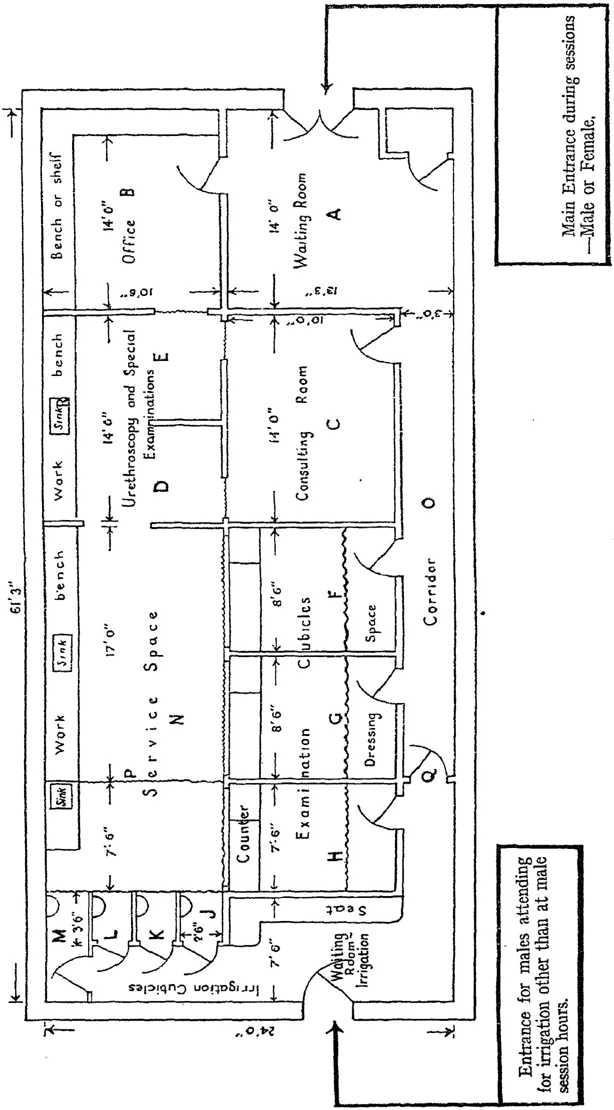


FIG. 1.

interfere with the work of the staff. Adjoining the consulting room C there is a room partially divided by a low partition (6 feet long) into two sections, D and E, for urethroscopy and all special examinations. In this way one patient can be seen in section D while another is getting ready in section E, or *vice versâ*. Both sections are served from one workbench R. The plan shows also how the clinic can be used at certain times for both sexes. By drawing a curtain P and closing the door Q a session for females can be held for intermediate treatment in the right-hand section while irrigation of males is proceeding in the left-hand section.

The following is a description of the working of a venereal disease clinic. Patients on arrival go to the inquiry window of the office. In the case of a new patient particulars are entered in a confidential register, a ticket with identification number is issued, a treatment card is made out and the patient is directed to one of the examination cubicles. Anti-syphilitic injections are given at fixed hours, but new cases are treated at once. Before each anti-syphilitic injection the patient is examined and is given a slip stating the dose to be injected. He is then directed to one of the cubicles. Urines are tested by an orderly passing from cubicle to cubicle, the medical officer follows and gives arsenobenzene and bismuthial injections. Patients attending for irrigation receive a coloured ticket giving details of the treatment required which they hand to an attendant at the irrigation cubicles. In the conduct of a venereal diseases treatment centre two principles are of the greatest importance, namely, retention of the patient under treatment until all tests of cure have been satisfied, and securing the treatment of contacts, *i.e.*, persons who have been infected by, or may have infected the patients. For both, an efficient social service providing for sympathetic handling of patient and follow-up in case of default are of the greatest value. The workers in this service should be specially selected for their tact and ability to handle frightened, depressed or maybe defiant patients or their contacts, and valuable training in such work is given by the Institute of Hospital Almoners. Apart from this, sympathetic handling by medical officers and their subordinates may make all the difference between a high and a low defaulter rate. A treatment centre, in short, should not be a treatment mill but a place where a patient is made to feel that his interests are paramount.

Enteric fever includes the conditions known as typhoid and paratyphoid fevers. The former is caused by the *Bact. typhosum* and the latter by the *Bact. paratyphosum A, B* or *C. Bact. paratyphosum C* is rarely found in this country, its occurrence being most frequently noted in Eastern Europe. *Bact. typhosum* can remain alive for considerable periods in fæces or in water, but does not appear to multiply outside the human body,

unless it gains access to milk. It is not killed readily by low temperatures. Both *Bact. typhosum* and *Bact. paratyphosum B* may be recovered from effluents from sewage works. Isolation of the organisms from water and sewage is made easier by the use of the special Wilson-Blair medium. (*J. Hygiene*, Camb., 1927, **26**, 374, Wilson and Blair.) The organism may be cultivated from the blood during the first week of the disease and from the fæces and urine after the first three or four days of illness. In mild cases the elimination of the bacilli in the stools may be very transient, in the urine even more so. Agglutination tests may be used after the sixth or seventh day and give the maximum response from the eighteenth to the twentieth day of the disease. Inoculation with T.A.B. vaccine induces a much higher titre of H (flagellar) than of O (somatic) agglutinins. Hence a relatively high titre of O agglutinins in an inoculated person is of diagnostic significance. Typhoid fever has an incubation period of ten to fifteen days (extremes are five to twenty-three days); rose spots appear in the second week of illness; isolation must be maintained till negative bacteriological findings have been returned after examination of the fæces and urine on three separate days. Paratyphoid fevers present much the same clinical picture as typhoid fever, but as a rule show a lower case fatality rate—2·5–3·5 per cent. as compared with 10 per cent. It has long been a disputed question whether *B. paratyphosus B* can, like many of the salmonella types, produce acute gastro-enteritis (food poisoning) or whether the symptoms are invariably those of enteric fever. In a recent outbreak 56 persons who had eaten home-made trifle were admitted to hospital within 72 hours with symptoms of acute gastro-enteritis and all gave cultural or serological evidence of infection with *B. paratyphosus B*. The trifle was prepared by a woman found to be excreting profusely paratyphoid B bacilli in both fæces and urine (*Public Health*, May, 1941, p. 139, Warren, S. H.; *J. of Hygiene*, No. 4, July, 1942, pp. 393–410, Savage, Sir W. G.).

Enteric fever is found all over the world and is endemic in certain areas. Seasonal prevalence in temperate climates is most marked in the last four months of the year. The age-group most commonly affected is fifteen to twenty-five years. Between five and twenty years males suffer more frequently, but females show a higher death rate. In England and Wales there were, during 1942, 858 notifications of enteric fever with 89 deaths. The death rate from this cause in England and Wales has been steadily declining till in 1942 it was the lowest ever recorded. The death rate from enteric fever is to a certain extent an index of the completeness of the sanitary measures practised in any country. Enteric fever is spread chiefly through the medium of water, food (especially milk, shell fish, uncooked vegetables and food sold already cooked,)

fomites and dust (see pp. 358 and 464; *Medical Officer*, 15th July, 1933, p. 25, Massey, A., and *B.M.J.*, 21st August, 1937, p. 369, Fraser, W. M., Glover, B. T. J. and Glass, V.). Infection through dust and flies was proved in the South African War, and in an epidemic occurring in a mining town in Southern Rhodesia in 1940 it was definitely proved that the infection was due to flies (*Medical Officer*, 22nd February, 1941, pp. 65–67, Jones, E. B.). Direct infection from an actual case occurs not infrequently, particularly among nurses and especially during epidemics. Modern knowledge goes to prove that many outbreaks are traceable to carriers. "It is generally regarded as probable that 2–5 per cent. of all cases of typhoid fever become permanent carriers, but when the disease is mild and infrequent, as in this country at present, the rate is probably lower. In countries where typhoid fever is comparatively common such carriers constitute 0·1 per cent. or more of the total population." Those who continue to excrete the bacilli for a year after the acute attack will probably become permanent carriers. Other individuals may excrete the organism, though they have never apparently been diagnosed as suffering from an attack of the disease. Carriers may thus be divided into (*a*) temporary, or those in whom the condition does not last more than a short period; and (*b*) chronic, or those in whom the condition persists for years. Women are commoner chronic carriers than men in the proportion of five to one. This is especially important in view of the possible contamination of food during its preparation for the table. The majority of chronic carriers are of middle age, and gall-stone trouble has been noted in 13·6 per cent. of them. On the other hand, temporary carriers are usually young persons, and though females are more numerous than males, the proportion is only 1·4 : 1. The bacilli may be excreted in both urine and fæces in the same individual, but the urinary carrier, though less common than the purely fæcal, is the more dangerous from his greater liability to contaminate his hands during micturition. In either case the bacilli tend to be discharged intermittently, so that, though the carrier may appear free during a period of weeks or even months, he may give positive results during later bacteriological examinations. If the number of suspects is small, cultures of urine and fæces should be made from all, on at least three separate occasions at intervals of a week. If the number is large, a preliminary selection by agglutination tests should be made. While the Widal reaction is said to be positive in the majority of carriers, it is essential to demonstrate the typhoid bacilli either in the fæces or urine before certifying any person as a carrier. Felix has demonstrated that the virulence of certain strains of typhoid bacilli and the fact that those strains are

not agglutinated by an O antiserum are due to a special antigen which he called the "Vi" antigen. Vi-agglutination arouses suspicion of the carrier state even in vaccinated persons, provided the vaccination was not carried out (with the new type of alcohol-treated T.A.B. vaccine—Felix, 1941) less than about two months earlier. A "Vi-positive" demands prolonged cultural examination with all the available adjuvants before freedom from infection is reported. Felix and others recommend the Vi-agglutination reaction as an aid to the detection of chronic typhoid carriers among whom the frequency of a positive Vi-reaction is high and is independent of the intermittency of bacillary excretion. (*J. Hyg.*, 1937, v. 37, p. 332, Pijper, A. and Crocker, C. G.; *Lancet*, 24th September, 1938, pp. 738–41, Felix, A.; *Amer. J. Hyg.*, 1940, v. 31 (B), p. 8, Elliot, C. P., also 1941, v. 31, p. 599, Elliot, C. P. and Cameron, W. R., also 1942, v. 32, p. 843, Coleman, M. B.; *B.M.J.*, 15th March, 1941, pp. 391–95, Felix, A.; *J. Infect. Dis.*, 1943, v. 72, p. 56, Klein, M.). Information of epidemiological value can be obtained by typing the infecting strain of bacillus by the bacteriophage method. Persons infected from the same human source will yield typhoid or paratyphoid bacilli of the same 'phage type. If in any outbreak bacilli of different 'phage type are isolated then more than one source of infection most likely exist. Outbreaks caused by contaminated sewage are often due to bacilli which belong to different 'phage types. It is, therefore, important that in all clinical cases the infecting organism should be isolated.

Under the Public Health (Infectious Diseases) Regulations, 1927, typhoid and dysentery carriers may be excluded from all trades concerned with the handling of food and drink (p. 554). The Public Health (Infectious Diseases) Regulations (Scotland), 1932, give local authorities power to remove to hospital, compulsorily if necessary, a carrier who has been certified as such by a medical officer of health and another registered medical practitioner. This certificate is valid for three months and may be renewed for similar periods. The certified person has the right of appeal to the Department of Health.

Strong presumptive evidence in support of the value of prophylactic vaccination against enteric fever was obtained during the war of 1914–18. In upwards of four years and in six theatres of war, with an average mean ration strength of nearly two million troops, there were only 20,149 cases of typhoid and paratyphoid fever, with 1,191 deaths, the total case mortality being 5·4 per cent. In the South African War the British Army employed 557,653 men with an average strength of 208,226. There were 57,684 cases of typhoid fever with 8,022 deaths. Such a marked difference in the incidence of enteric infection could hardly have been accounted for by

improved field sanitation alone. During the present war the value of T.A.B. vaccine has been amply vindicated by the absence of enteric fever amongst British prisoners in Italian camps where the sanitary conditions were bad and the disease existed among enemy troops in the neighbourhood. (*B.M.J.*, 12th June, 1943, pp. 719–21, Boyd, J. S. K.) Not only is the vaccinated individual far less liable to contract typhoid than the unvaccinated, but in the event of his being infected he is much less likely to succumb. When an outbreak of typhoid fever has been traced to a definite source such as infected water or milk and the source has been adequately dealt with, *e.g.*, by chlorination or by pasteurisation, there is no need to offer immunisation to the general public. All persons who are going to contract the disease, except as secondary cases to existing infections, will have already done so, and some workers show that vaccination performed during the incubation stage tends to aggravate the disease. Such an aggravated condition is sometimes known as "provocative typhoid" (*Lancet*, 22nd January, 1938, pp. 181–86, Topley, W. W. C.).

The prophylactic vaccine usually employed contains 1,000 million *Bact. typhosum* and 750 million each of *Bact. paratyphosum A* and *B*. Sometimes 750 million of *Bact. paratyphosum C* are also added in the case of people going to countries where the disease is endemic. The dose is 0·5 c.c. followed after ten days by 1 c.c. It is generally recommended that for all save the very robust half the usual dose should be given, as weakly and ill-nourished individuals are very sensitive. The dose should be suitably graduated in the case of children, and the following is suggested. For those aged 2–4 years the vaccine should be diluted ten times with normal saline and two doses of 0·25 c.c. and 0·5 c.c. respectively given. For children aged 4–15 one-eighth of the adult dose is suggested for the first injection followed by one-fourth of the adult dose, and for those aged 15–18 years, one-fourth followed by one-half. For those living in endemic areas a reinforcing dose of 0·5 c.c. should be given every year. Oral vaccination against enteric, as advocated by Besredka, is in no way comparable with that produced by the standard vaccination.

Great care must be exercised in disinfecting all bed linen and articles handled by a patient. The fæces and urine must be treated with special care. It is advisable to soak all linen in a cold solution of 1 : 1,000 perchloride of mercury, and subsequently to disinfect with steam under pressure. Fæces and urine should be received into vessels containing some 5 per cent. carbolic acid, and more disinfectant should be added after use. At least two hours' contact with the disinfectant should be given before excreta are discharged down the drain. When a water-carriage system is not available, excreta should be either

buried in lime or burnt after disinfection (Min. of Health Memo. 225/Med., 1939).

Dysentery. Amœbic dysentery is due to the protozoon *Entamœba histolytica*, and is a disease of tropical and sub-tropical countries. It is the cyst form of the protozoon that conveys infection, for it is very resistant outside the body. It is found in the formed stools of convalescent cases, and may contaminate water supplies, food and dust. Flies may swallow the cysts and pass them unaltered in their fæces. It has been found that quite a number of persons who have lived all their lives in this country may be infected with *Entamœba histolytica* without showing any symptoms. A serious outbreak occurred in Chicago in 1933 due probably to a contaminated water supply (*Med. Off.*, 15th December, 1934, p. 243, Bundesen). The main features of the condition are the frequency of liver abscess as a sequela, particularly in inadequately treated cases, and the amenability of the condition to emetine in the form of emetine hydrochloride given by deep subcutaneous or intramuscular injection.

Bacillary dysentery is most commonly caused by Shiga's, Flexner's or Sonne's *Bact. dysenteriæ*. The Shiga bacillus, which is rare in this country, produces a more severe dysentery and has a greater tendency to epidemic spread than the other types. Asylum dysentery is usually due to the Flexner or to the Sonne species. Bacillary dysentery is constantly present in the tropics, but is also common in temperate countries. It was a cause of quite considerable invaliding in France during 1914–18. In 1939 some 1,941 cases of bacillary dysentery were notified in England and Wales. Dysentery is liable to occur in children's hospitals and homes and is especially fatal to young infants. No child suffering from severe diarrhœa should be admitted to a general ward until a bacteriological examination of the fæces has been made. The incubation period varies from one to seven days, and the disease is characterised by much tenesmus and fluid stools, consisting mainly of blood and mucus in the later stages. Inasmuch as the disease is helped in its spread by overcrowding and dirt, it has always been looked upon as an almost inevitable accompaniment of military campaigns. The case mortality varies very much, from 6 to 30 per cent. Infection is conveyed in the same way as in typhoid fever, and the preventive measures are identical. Remarkably good results have been obtained from the early treatment of acute bacillary dysentery with sulphaguanidine. In a number of cases where the diagnosis was made certain by the recovery of the organism from the fæces, the stools became normal in forty-eight hours. (A small milk-borne outbreak is described in the Ministry of Health Report, No. 20, 1923.) Power to control carriers is granted under the Public Health (Infectious Diseases) Regula-

tions, 1927. Prophylactic vaccines have given more or less encouraging results. A useful review of bacillary dysentery by W. M. Scott will be found in the *Lancet*, 1st October, 1938, p. 796.

Other forms of dysentery are due to *Lamblia intestinalis* and *Balantidium coli*, but both conditions are rare in this country.

Epidemic enteritis, which may be caused by a number of different organisms, is of special consequence, inasmuch as diarrhœa proves fatal to many children under one year of age. In 1914 in England and Wales there were 17·37 deaths of infants from this cause per 1,000 births; in 1942 this figure had fallen to about 5. A marked decline, however, occurs after the first year of life. The disease is much more prevalent in large towns than in the country. In the county boroughs of the North in 1914 the infant mortality rate from diarrhœal diseases was 23·54, while in rural districts of the South it was only 6·11.

Diarrhœa is frequently an accompaniment of hot summers. Thus in 1911 (a hot summer) the infant mortality rate in England and Wales from this disease was 36·20, while in 1912 it was only 7·72. In 1921, another hot year, the rate was, however, only 14, and since then no higher rate than 8 has been recorded. The highest mortality occurs in the third quarter of the year, but the fall is prolonged far into the fourth. The disease is more prevalent among bottle-fed than among breast-fed children. It is also more widespread in towns where scavenging arrangements are poor, where no water-carriage system is in use, where yards are badly paved, and where much contaminated dust is present ready to infect any milk, etc., on which it may be blown. Flies are a common medium of infection.

Very good results have been obtained from treatment with sulphaguanidine, one of the less toxic sulphonamides (*B.M.J.*, 3rd April, 1943, pp. 410–13, Henderson, J. L.).

Attention has been drawn to the close association between otitis media and epidemic enteritis and it is suggested that use should be made of sulphapyridine on the first appearance of ear symptoms or signs of otitis in school children (*B.M.J.*, 1st February, 1941, pp. 151–154, Bloch, E.).

Preventive measures consist in thorough cleansing and watering of all streets during hot and dry seasons, protection of all food from flies and dust and the pasteurisation or boiling of milk.

The frequency of infection with *Giardia lamblia* in young children is high. Mepacrine (atebrin) is specific and generally cures the infection within a few days. It is found in healthy children as well as in those suffering from gastro-enteritis, and no accurate information is yet available as to its possible

pathogenicity, either as a cause of outbreaks of this disease or of chronic ill-health.

Cholera is due to the vibrio of cholera. It is not a very resistant organism, but it appears to remain alive for considerable periods (even months) in ordinary water. In stools not exposed to light it may be recovered after two to three weeks. It is readily killed by drying, sunlight, heat and disinfectants. There would appear to be various types of vibrio, and work in India seems to show that only those vibrios which agglutinate with a pure O type serum are consistently associated with cholera.

The disease is endemic in Lower Bengal and has spread from there all over the globe. Pandemics occurred in 1826–32, 1840–49, 1848–53, 1863–66, 1866–70 and 1892–94. From 1904 to 1911, it was somewhat widespread in Russia, Southern Italy, Portugal and Turkey. England was affected in 1831, 1848–49, 1854 and 1865–66. Cholera has reached Europe along the main lines of travel from India: (1) through Afghanistan and the caravan routes to Russia; (2) by the Gulf of Persia to Syria and Egypt and across the Caspian to Russia; (3) by the pilgrim traffic to the Red Sea, thence to Egypt and the Mediterranean; (4) by the trans-Caspian railway and the Caspian steamers to Russia in 1892. Thus the quicker the means of transport the more rapidly is cholera liable to spread. This country has usually been infected from Russia and Germany *viâ* our North Sea ports.

The incubation period varies from a few hours to five days, and the patient remains infectious as a rule till the stools become fully formed again. Sufferers must be isolated till no vibrios can be discovered in the excreta. The case mortality is high, usually 30–50 per cent., children and old persons being specially liable to succumb. In Europe the greatest prevalence was reached from June to August, and the disease usually died down with the approach of cold weather.

Cholera is thought to be spread mainly by carriers, through the agency of food, water and fomites, aided by defective sanitary arrangements and flies. Convalescents rarely remain carriers for more than four or five weeks, but contacts and others may become carriers without even having suffered from a recognisable attack of the disease. Flies may discharge vibrios in their fæces for a day and a half after feeding on cholera stools. During outbreaks of the disease no uncooked food should be eaten, raw fruit and vegetables being especially dangerous. All milk and water should be boiled. Strict isolation of patients must be practised and careful disinfection of all excreta, clothing, etc., carried out. Prophylactic vaccination with Haffkine's vaccine has proved useful. The initial dose is 4,000 millions, followed by a second dose of 8,000 millions

seven to ten days later. A modified immunity lasting for a few months is conferred.

Cholera is one of the diseases specially dealt with in the Sanitary Convention, 1926, which has been given effect to in this country by the Port Sanitary Regulations, 1933 (p. 642). A sound system of port health administration is our best safeguard against the importation of cholera. (See also Convention for Aerial Navigation, p. 650, and P.H. (Aircraft) Regulations, 1938, p. 649.)

Malaria is caused by one or other of three species of parasite : (1) *Plasmodium vivax*, which produces benign tertian malaria ; (2) *P. malariæ*, quartan malaria ; and (3) *P. falciparum*, malignant tertian.

The parasites have an asexual phase in the red blood corpuscles of man and a sexual phase of which only the early stage is found in human blood. The rest of the sexual phase is passed in certain anopheline mosquitoes. When a female mosquito of the kind capable of transmitting malaria sucks human blood containing these sexual forms or gametocytes, fertilisation of the female by the male parasite takes place in the stomach of the mosquito, with the ultimate formation of sporozoites, which find their way to the salivary glands of the insect. When such an infected mosquito bites another human being some of the sporozoites are injected into the blood and enter the red blood corpuscles. There they develop into the asexual forms, which give rise to the well-known symptoms of malaria. A few days later some of these asexual parasites become male and female sexual forms ready to continue the cycle should they enter the stomach of a suitable mosquito. At a constant temperature of 77° F. the benign tertian parasite completes its cycle in the mosquito in about eleven days, and at temperatures averaging 62·5°–68° F. in fifteen days. The lowest temperatures at which the parasite will develop are between 59° F. and 62·5° F., and the time required is fifty-three days.

Three conditions are necessary for the conveyance of malaria : (1) an anopheline mosquito must have bitten a man suffering from malaria at least fifteen days previously (in England) ; (2) the man must have had in his blood sexual forms of the parasite ; (3) the atmospheric temperature must have been favourable. These three conditions may be found in any malarial country where a large number of infected persons and millions of anophelines are present at the same time. In England the likelihood of spread is not great. Useful indications of prevalence may be obtained : (1) by catching several hundred female anophelines and, by dissection, examining them for sporozoites in the salivary glands ; and (2) by the discovery of enlarged spleens, especially among the child (three to ten years of age) population of any district.

Malignant malaria is commonest in the tropical zone lying between 23° N. and 23° S.; both malignant and benign tertian malaria occur in the sub-tropical zone between 23° N. and 40° N. and 23° S. and 40° S.; in the temperate zone north of 40° N. malaria, usually of the benign tertian form, is found in various areas although malignant malaria may also occur. The disease, though formerly prevalent in certain districts in England, is now practically unknown in indigenous form.

Malaria is the most important of all tropical diseases. Not only does it kill and incapacitate millions of human beings every year, but its effect on the economic condition of a country may be very far-reaching.

Methods of prevention and treatment. 1. Use of drugs. The Fourth General Report of the Malaria Commission of the League of Nations (December, 1937) contains some useful suggestions. (*a*) *Individual treatment of patients.* In ordinary cases of *P. vivax* (benign tertian) infections, it is almost immaterial whether quinine or atebrin is employed for treatment of the attack. Plasmoquine, associated with quinine or atebrin, or administered after these drugs, has no appreciably useful effect on the attacks, but seems to reduce the frequency of subsequent relapses. The association of plasmoquine with quinine, or its administration after atebrin, is useful in *P. falciparum* infections, on account of its action on gametocytes and relapses. (*b*) *Treatment in the field.* Atebrin, when used for collective treatment in daily doses of 0·30 grm. (for adults) for five to seven days, acts in the same way as quinine in daily doses of 1 grm. to 1·30 grm. for five to seven days or more. There is no reason, save financial considerations, why either quinine or atebrin should be preferred. Collective treatment with quinine or atebrin may usefully be accompanied or followed by plasmoquine treatment, in order to diminish the number of gametocytes and the risk of relapses. (*c*) *Mass drug prophylaxis.* Mass drug prophylaxis has a twofold purpose: (1) to protect the population undergoing prophylactic treatment from the clinical manifestations of endemic malaria, in order that its working capacity and comparative standard of health may be safeguarded without injury to its premunisation, even in areas in which it is exposed to repeated reinfection; (2) to reduce, in due course, the sources from which the local mosquitoes may be infected. No prophylactic method, unless applied to disciplined communities under stringent supervision, is capable as yet of attaining these two objects. Drug prophylaxis should be started some days before reaching an endemic area and experience has shown that a large measure of protection can be obtained by the daily administration of doses of quinine (0·4 grm.) during the whole of the malarial transmission season and a few weeks longer. This is also true

in the case of mepacrine given in bi-weekly doses of 0·20 grm. (= 0.40 grm. per week) for ordinary endemic areas and six daily doses a week of 0·1 grm. (= 0·6 grm. per week) for hyperendemic areas. The harmlessness of quinine makes it a suitable drug for administration by subordinate personnel without constant medical supervision. Owing to the present difficulties in the supplies, however, mepacrine has almost entirely replaced quinine for the suppression of malaria.

2. Protection against mosquito bites is secured by properly arranged bed nets with a mesh of at least eighteen to the inch, and special clothing to protect the head, face, neck and hands. The best pattern net is the rectangular type hung inside the poles, the free edge of the net being hemmed with a strip of cotton or other material 1 foot to 18 inches wide. This strengthens the net and prevents bites on exposed parts of the body against the net during sleep. When in use the net should be tucked all round under the mattress. Houses should be mosquito-proofed by means of non-corrosive wire netting. Imperfectly screened houses are dangerous in that mosquitoes will probably succeed in entering and will remain long enough to infect all the inmates. (See p. 188). Hence hand-catching of mosquitoes is necessary in all houses where screening is adopted.

3. Segregation of the healthy by inducing them to live at least half a mile away from the site where malaria is endemic.

Methods of eradication. 1. The discovery and treatment of all malaria cases and carriers is a method particularly applicable to parts of England that may be threatened with malaria.

2. The elimination of all malaria-carrying mosquitoes (see p. 186).

(*Trop. Dis. Bull.*, April, 1933, pp. 193–202 ; and June, 1933, pp. 343–349 ; Min. of Health Memo. 238/Med., revised 1942; *B.M.J.*, 18th July, 1942, pp. 61–63, "Diagnosis and Treatment of Malaria in England," Yorke, Warrington.)

Yellow fever is endemic in foci in Central and South America, as well as in West Africa from Senegal to the Congo. and in East Africa. The disease is due to a filter-passing virus, and is communicated by the bite of the female mosquito, *Aëdes œgypti*, other species of *Aëdes* and other genera of mosquitoes. The mosquito becomes infective only after a variable period of time, depending on the atmospheric temperature (optimum about 79° F.). Once infected, however, the mosquito may remain so for months. Only the female mosquito is concerned in the transmission of yellow fever. The *Aëdes œgypti* is a domestic mosquito breeding in the neighbourhood of houses in any collection of water. It tends to remain within 100 yards of its breeding-place; hence vessels moored a quarter of a mile off the shore are quite

safe from attack. The incubation period does not exceed six days, and case mortality is high, up to 75 per cent. Whites appear to be more susceptible than natives. Preventive measures imply an anti-mosquito campaign. Cuba was freed from yellow fever in this way. A "jungle-type" of yellow fever is met with in certain areas where no *Aëdes* has been discovered, *e.g.* Brazil.

Much of our modern knowledge of yellow fever is due to the work of the staff of the Rockefeller Yellow Fever Commission. They showed that the blood serum of persons who have suffered from yellow fever, however long ago or in however mild a form, protects the monkey (*Macacus rhesus*) from the effects of inoculation with yellow fever virus. It was later discovered that white mice could be infected with yellow fever virus by intracerebral inoculation of the virus. An encephalitis is set up and the brain tissue of such mice on inoculation into monkeys will reproduce the disease.

By means of a "mouse protection" test it is possible to say whether a given specimen of blood serum has been obtained from an individual who has at some time or other been infected with the virus of yellow fever. In this way areas where yellow fever is endemic may be defined. There is one large area in South America from Colombia in the North, to Paraguay in the South. Another is in Africa, extending from the Atlantic coast along latitude 15° North to the eastern limits of the Anglo-Egyptian Sudan boundary. It includes a large part of East Africa as far as 10° South and extends along this parallel to the west coast of Africa. As a result of continuing investigations, this area of endemic prevalence is constantly under revision. As there is difficulty in differentiating mild cases of yellow fever from other febrile conditions in endemic areas, a sample of blood for a yellow fever immunity test should be taken from all persons suffering from an undiagnosed fever. A specimen should be taken in the very earliest stage of the fever and stored at a low temperature until despatched to a laboratory. If the cause of the fever is doubtful and the patient recovers, a second sample should be collected at the end of the third week from the onset of the illness. The two specimens should then be sent to the nearest laboratory where immunity tests are carried out. If the patient dies within ten days of the onset of the illness, a specimen of liver tissue should be taken, if necessary by a viscerotome, and forwarded to the nearest laboratory that undertakes the histological diagnosis of yellow fever.

A virus strain of low neurotropism made up with distilled water is used for prophylactic inoculation. One injection is given and there is little or no reaction. Immunity begins to develop on the tenth day, reaches its maximum in about three weeks

and lasts for about four years. To prevent jaundice which has occurred in a number of cases in the past, the human serum component has been left out of the vaccine and it is believed that the risk has been eliminated.

The International Sanitary Convention for Aerial Navigation, 1933, contains important clauses setting forth what the signatory Governments must do to prevent spread of yellow fever by aircraft. Such countries must search for cases of the disease and endeavour to define infected areas. Measures for preventing spread by aerial traffic must be taken primarily at air-ports of departure in suspected countries. These measures include the requirement that crews and passengers shall have been free from any risk of infection during six days preceding embarkation and that the aircraft and cargo shall be free from the possibility of conveying mosquitoes (see p. 231). In countries where yellow fever is endemic special sanitary or "anti-amaryl" aerodromes must be established.

An Inter-Departmental Committee was set up in 1941 to review the terms of the above Convention, to study public health problems of aerial travel in relation to war activities and to try to co-ordinate the control of yellow fever between all the departments concerned including the Services.

As a result of this Committee's deliberations, "endemic" area now includes any region in which yellow fever exists or has existed during the past fifteen years in any form recognised clinically or otherwise. Control and disinsectization should be concentrated at aerodromes outside endemic areas. Aerodromes situated within an endemic area must no longer be termed "anti-amaryl" (i.e. anti-yellow fever). All persons passing through endemic areas must carry certificates to the effect that they have been inoculated against yellow fever more than fifteen days previously. Such certificates are valid for four years. All persons employed on or about aerodromes should also be inoculated. (Interim Report of the Inter-Departmental Committee on Yellow Fever Control, September, 1942, Colonial Office; Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. XXXVI, No. 6, May, 1943, p. 322, Smart, A. G. H.)

Dengue, or "breakbone fever," is another mosquito-borne disease prevalent in tropical and sub-tropical countries. *Aëdes ægypti* is the mosquito principally concerned in the transmission, but there are possibly two other types involved and a dengue reservoir may be found in uninhabited jungle areas. The virus, which is apparently a filter-passer, is present in the blood of a patient during the first three days of the disease, and the mosquito becomes infective from the eleventh to the fourteenth day after feeding on an infected person, and may apparently

remain infective for an indefinite period. The incubation period is given as five to ten days, and the disease is characterised by rash, severe pains and "saddle-back" temperature. The mortality is negligible, but convalescence is frequently long. A severe epidemic of dengue occurred in Greece in 1928, and the need for preventing the spread of the disease particularly in countries bordering on the Mediterranean resulted in the preparation of an international agreement by the *Office International d'Hygiène Publique.* This agreement provides for notification of an epidemic of dengue in one country to the other signatory countries, destruction of mosquitoes and their larvæ in ships leaving an infected port, medical examination of patients on board ship who have been suffering from dengue for less than five days and their isolation on disembarkation in such manner as to protect them against mosquito bites, and in exceptional cases surveillance of passengers and confinement of crew on board ship until eight days have elapsed since exposure to infection. (*Bull. Hyg.*, January, 1933, p. 11.)

Phlebotomus fever, or sand-fly fever, is due to a filtrable virus conveyed by the bite of a tiny fly, *Phlebotomus papatasii.* It occurs in most tropical and sub-tropical countries. The incubation period varies from four to seven days, and the fever lasts three to four days. The blood of a sufferer is infective only on the first two days, and apparently the fly cannot transmit the disease till after six days. A fine net with a mesh of at least twenty-two to the inch is necessary to protect against these tiny flies.

Typhus fever. The term typhus fever may be taken to include two main categories, all the diseases in which are associated with bodies, usually intracellular, known as *Rickettsia.* In the first of these there is only one member—exanthematic typhus transmitted by lice from man to man and common in temperate and cold climates. In the second are included a number of conditions passing under the generic name of endemic typhus and grouped either geographically or, more scientifically, according to the vector concerned. Thus there are the diseases such as *fièvre boutonneuse* in the Mediterranean, Brill's disease mainly in America, Malayan typhus, etc. Rural typhus of Malaya is identical with tsutsugamushi of Japan. The flea is the vector (rat the reservoir) in the case of Brill's disease and one of the Malayan fevers, a tick (dog the reservoir) in the case of *fièvre boutonneuse* and African tick typhus. Closely allied to these typhus diseases are Japanese River fever conveyed by a mite (field mice the reservoir) and Rocky Mountain fever of America transmitted by a tick (rabbit, squirrel, etc., the reservoirs).

European typhus is caused by *Rickettsia prowazeki,* of which

man is the only reservoir, and it is spread by the *Pediculus vestimenti.* There is no evidence that it is spread by any other agent. Although *P. capitis* is a variety of *P. vestimenti*, it is not known to spread typhus. Man can react to many other *rickettsiæ*, but the diseases caused by them are local, usually not serious and in none except true typhus is man the reservoir. It is not known whether man develops a true immunity to *R. prowazeki*, but it is certain that he develops a benign symbiosis with the parasite and his recovery and subsequent freedom from further attacks seem dependent upon this symbiosis, known as "premunition." When he loses the parasites his immunity also disappears. A person infected with *R. prowazeki* becomes a reservoir, whether or not he develops reaction. A premunitioned person does not generally act as a spreader of the disease, although he may do so at any time, even many years after infection, and this explains the sudden reappearance of typhus in places where the disease has been absent for long periods and importation can be excluded. It is not known why this happens but, for typhus to occur, there must be a reservoir either native or imported, there must be body lice and a population that is not premunitioned. The disease becomes epidemic usually only when poverty, malnutrition and defective hygiene are prevalent, as in time of war.

Till 1869 typhus fever was not distinguished separately in the Registrar-General's returns. For centuries past the disease has been the accompaniment of famine and war. "Gaol Fever" was another name for the condition, owing to its prevalence in the overcrowded and insanitary prisons of many years ago. A few cases occur from time to time in this country, mainly in Ireland and ports such as Liverpool and Glasgow. During the War (1914–1918) a good deal of typhus was reported from Serbia and among the Austro-German forces. These bodies have been found in the intestinal epithelium of lice taken from cases of typhus fever, and in the blood-vessels in the skin, brain, kidneys, muscles, etc., of typhus patients. The disease is always contracted from other human beings through the louse. The louse becomes infected by biting a sufferer during the eruptive period of the disease, and once infected it apparently remains so indefinitely. Infection may occur either through the bite of the louse or through infected louse excrement being rubbed or scratched into the skin. There is also danger of infection by air-carried fæces of the louse. It is just possible that the virus may be handed down from one generation of lice to the next.

The incubation period is between five and fourteen days, usually twelve, and patients are infectious throughout the whole of this period. The rash appears on the fifth day; convalescence sets in about the third week, but the virus may possibly

persist in the body for three weeks after the temperature has become normal. This implies an isolation period of some six weeks and observation of contacts for about twenty-one days. Seasonal prevalence is most marked during the colder months, when lousiness is also greatest, as more clothing is worn and less washing practised. Case mortality in the Serbian Army was 50 per cent.; in uncomplicated cases among Serbian prisoners it was 25 per cent. Murchison gave the average rate as 10 per cent. Among older persons, however, the disease is very much more fatal, and younger ones should therefore be employed during a typhus epidemic.

Preventive measures are mainly directed against lousiness (see p. 192)—no lice, no typhus fever. When a person begins actually to suffer from typhus the numbers of infected lice greatly increase. During an epidemic the most dangerous work is the search for cases, the removal and disinfestation of bedding, the admission of patients to hospital and the collection of blood for the Weil-Felix reaction. Before removal to hospital patients should be completely enveloped in a large sheet and carefully lifted on to a stretcher so that no lice are shaken off in the process. Attendants collecting cases from dirty neighbourhoods should wear suitably protective garments. These should be white if possible and washable and should consist of a one-piece garment reaching to the wrists and ankles and including a hood for the head. The hair should be cut short. Gum boots and gloves should also be worn. As an additional precaution the gaps between the gloves and the garment or at the top of the boots may be sealed with adhesive tape or a small fillet of wool smeared with vaseline containing 5 per cent. xylene. When the garments are taken off they may be dropped into a closed receptacle (*e.g.*, a dustbin with a good lid) and sprinkled with flake naphthalene. Any lice will be destroyed before the next day. Protective clothing must not be worn for more than three hours for in such time lice may have found their way through any weak spots. All clothing and bedding should be treated by steam, preferably under pressure. *When mass disinfestation is necessary on account of an outbreak of typhus fever a centre should be provided which should have a laundry, a high pressure steam disinfector or a hot air disinfestor and spray baths. There should be complete separation between the clean and dirty sections of this unit. The Millbank portable hot air disinfestor and drying machine is useful for mass disinfestation. This consists of a canvas-covered tubular framed structure which can be quickly assembled and which can be transported on a 30-cwt. lorry. The heat is provided by two pressure petrol Hydra stoves. The hot air is driven by a fan through a duct into a contact chamber and liberated

* See p. 192.

through holes at floor level, and to ensure circulation is extracted through another duct. There are two chambers each with a capacity of 432 cubic feet and while materials in one are under treatment the other is being emptied and refilled. The materials to be disinfested are suspended from rods inside the chamber. A minimum surface temperature of 70° C. throughout the whole of the clothing is maintained for a maximum period of thirty minutes and this will destroy the louse in all its stages as well as the *Sarcoptes scabei*. It should be remembered that both the virus of trench fever and that of typhus are more resistant to dry than to moist heat. (*J. Royal Army Medical Corps*, vol. 74, 1940, pp. 121–137, Richmond, A. E.)

The Weil-Felix reaction consists in the agglutination by the patient's serum of a culture of *Prot. vulgaris X*19. An agglutination titre above 1 : 1,000 occurs only in typhus. The reaction appears about the end of the first week, reaches its maximum about the end of the second week and gradually falls during convalescence. It may persist, however, for months. (*Trop. Dis. Bull.*, June, 1933, pp. 343–349.)

Protective inoculation, consisting of three injections of a killed suspension of *rickettsiæ* prepared by Cox's yolk sac method and given at intervals of from five to seven days, is now being tried out on a very large scale. Although the experimental evidence in the prevention of laboratory infections had suggested that the chief value of such vaccines was in reducing the severity of the disease, data are accumulating which suggest that the newer vaccines actually reduce the incidence of infection. Statistical evaluation of the true prophylactic value is, however, still lacking. Killed vaccines have the drawback that they require inoculation of large quantities of the germs at repeated intervals and, as three injections are necessary at intervals of from five to seven days, a total period of about three weeks must elapse before the maximum immunising effect is produced. When an epidemic is widespread and the population is a shifting one and is lousy, a live vaccine, in spite of its risk, should be used because of its rapid preventive action following on a single injection. The method of Blanc (biliated flea virus) and that of Laigret-Durand (mouse-brain) are the only ones that should be considered for the preparation of live vaccine intended for Europeans. (Min. of H. Memo. 230/Med., 1940, "The Louse and How to Deal with it" ; Memo. 252/Med., 1941, "Louse-Borne Typhus Fever" ; Rockefeller Foundation, Report of Health Commission, June, 1940, to June, 1941, pp. 76–82, "Typhus Fever" ; *B.M.J.*, 3rd and 10th October, 1942, pp. 401–3 and 433–5, "Louse-Borne Typhus Fever," Megaw, J. W. D. ; League of Nations Bull. of Health Organisation, Vol. X, No. 1, 1943, "Typhus Fever.)

Relapsing fever is due to the *Treponema recurrentis*. The disease was once common in Great Britain. In Eastern Europe epidemics occurred after the War (1914–1918), while in India relapsing fever assumes epidemic proportions from time to time. Infection is conveyed by lice, especially *P. humanus vestimenti*, probably through their infected fæces or body juices being rubbed into abrasions in the skin. After feeding on a patient the louse becomes infective in from five to sixteen days, and remains so indefinitely. During paroxysms of the disease the spirochæte may be recovered from the peripheral blood. The incubation period is usually from five to ten days; the characteristic feature of the disease is recurring attacks of fever over a period of twelve to sixteen days; case mortality is about 4 per cent. Preventive measures should be directed against body vermin of all sorts.

Plague. Since the great plague of 1665 this country has been more or less free from visitations. In 1894 an outbreak appears to have originated in the interior of China, in 1895 Hong Kong was affected, in 1896 extension to India occurred, and thence it spread to every corner of the globe. Some authorities trace the origin of the disease to infected "tarbagan-marmots" on the borders of Mongolia and Manchuria, and assert that cases occurred prior to 1894 in native hunters and trappers of those animals. Rats became infected in more populous localities, and the disease was spread generally through the agency of rat fleas. Cases of plague occurred in Glasgow in 1900, and a few have been detected in various ports in this country from time to time. In 1910 a small outbreak was recorded in Suffolk, where the local rats were found to be infected. Plague is really an epizoötic in rats, which may become chronic carriers, and in other rodents, among which a heavy mortality usually precedes an epidemic in man. Epidemics of plague in man are invariably preceded for ten to fourteen days by epizoötics in black rats and these by epizoötics in brown rats. Domestic rats are not wholly responsible for the maintenance and dissemination of plague. A considerable number of wild rodents in various parts of the world have been found to spread it. Most of these rodents living in rural or desert places maintain infection and through their agency and that of their fleas plague may pass across wide tracts of country without coming into contact with man or his attendant rats. Thus plague in a town may spread to the rural rodent population, pass to the rat population of another town and thence to man. The disease is due to the *Past. pestis*; the organism is but little resistant outside the body of its various hosts. Bubonic plague is conveyed from rat to man by the rat flea (chiefly *Xenopsylla cheopis*); when rats fall ill or die, the fleas leave their hosts. Such fleas may remain infective for upwards of six weeks. It

has been suggested that a "cheopis index" of less than one per rat indicates that rat plague will not easily spread; as the index rises above one so does the danger of infection increase. In the Port of London of 1,094 rats examined (683 black and 411 brown) on only two rats were *Xenopsylla cheopis* found; the average number of fleas per rat was three and the predominant flea was *Ceratophyllus fasciatus*. Both the brown and the black rat may be infected, but as the latter is more closely associated with man it is the greater source of danger. Rats are brought to this country from infected ports, especially in grain and cotton ships. After a flea has sucked infected blood the plague bacilli multiply in the gastro-intestinal canal and may gradually block the œsophagus. Through the efforts of the flea to suck blood some of this mass is regurgitated on the skin of the next individual attacked by the flea. The organisms may be rubbed into the puncture wound and bubonic plague result.

The incubation period is usually three days; patients should be isolated for a month. Age and sex have little influence. Seasonal prevalence is most marked during the cool season in hot climates. A temperature of over 80° F., combined with absence of moisture, usually brings an epidemic to a close. In this country, conversely, plague might be expected to occur in late summer and early autumn. In India, case mortality has generally amounted to about 75 per cent., and from 1896 to 1914 eight and a quarter million persons died of plague. In 1939, however, it was reported that a considerable diminution in the incidence had taken place in India within the last decade and this satisfactory position was maintained in 1940. Treatment with sulphanilamide is stated to have had encouraging results. Europeans suffer much less and show a lower mortality than natives.

Three forms of plague are distinguished:—

1. Bubonic plague, the least fatal; infection conveyed by fleas and not directly infectious from man to man.
2. Pneumonic plague, where infection is conveyed through the droplets of sputum given off on coughing—fatal form.
3. Septicæmic plague—rapidly fatal.

Preventive measures include the rat-proofing of houses and the destruction of rats. The use of suitable protective clothing by persons attending cases of plague is essential, and masks should be worn if the disease is of the pneumonic type. Haffkine's vaccine confers a considerable immunity for 6–12 months. Officers of port health authorities are constantly on the watch for plague-infected rats, and powers are given in the Port Sanitary Regulations, 1933 (p. 642), with a view to preventing the importation of plague into this country. If a rat is reported to be plague-infected it is important to know exactly where it

was found. In the Port of London a label with a serial number is attached to one leg and a letter combination on the label indicates the dock group in which the rat was caught or picked up. The rat officer enters this information in his daily journal with appropriate notes showing where and how each rat was obtained. When rats are sent to the bacteriological laboratory they are placed in a linen bag saturated with paraffin to ensure that the fleas are killed and then enclosed in a tin box. For the diagnosis of rat-plague the naked-eye post-mortem appearances are not relied on, but a smear is made from the spleen in every case and examined microscopically.

Cases of plague are removed to hospital and the quarters occupied by the sick, together with their bedding and clothing, are disinfected. Close contacts are disinfested if necessary. Passengers and crew are medically examined and their names and addresses forwarded to the medical officers of health of the districts of destination where they are kept under surveillance for six days. (*Proc. Roy. Soc. Med.*, Sect. of Trop. Dis. and Paras., Vol. XXVIII., March, 1935, pp. 25–36, "Plague: Modern Preventive Measures in Ships and Ports," White.)

Rats. Two species of rat are of special consequence—*Rattus rattus*, or black rat, and *R. Norvegicus*, or brown rat. In Britain generally the black rat is rare, but it is still common in ships and ports. In the city of Liverpool the proportion of black rats to brown is about one to nine, but in the dock area the proportion is ten to one. There is no recognised difference in colour, in spite of the names. The two species may be distinguished in the following way: the black rat is much lighter in build, its tail is never shorter than the head and body combined, its ears are large and translucent, and its hind feet from the heel to the tip of the toe (exclusive of the nail) are not longer than 40 mm. The brown rat is larger, more clumsy, blunt-nosed, has small, thick ears, and hind feet at least 45 mm. long. The black rat feeds mostly on grain, while the brown rat eats filth of any sort. Rats begin to breed when only two months old, and five or six litters may be born in a year. The number per litter averages eight in the country and ten in the towns. The normal gestation period is about twenty-one days. Both brown rats and mice can adapt themselves to extremes of temperature, and have been found breeding in cold stores at a temperature of 17° F. House mice have produced and reared their young at this temperature, making their nests in frozen bags of kidneys, which appear to be their favourite diet in these circumstances. All had grown slightly thicker fur as well as layers of fat underneath the skin. The black rat has never been found in cold stores.

An organised campaign against rats is necessary, not only on account of the damage they inflict upon foodstuffs, etc., but by

reason of their significance as carriers of disease. As rats move about either in search of food or at changes of season, and are specially liable to leave an area where they are in any way disturbed, the best-laid plans are apt at times to go astray. (See Rats and Mice (Destruction) Act, 1919, p. 674.)

Rat Destruction. The destruction of rats must be systematic and carried out over a wide area, working from the periphery towards the centre. Many districts now arrange for periodic "rat weeks." The following methods of destruction may be employed.

Poisoning. Poison baiting is probably the best method for destroying rats. It can be used almost anywhere and does not involve heavy expenditure on labour or apparatus. The poisons in common use are: red squill (powder or extract), barium carbonate, arsenic and phosphorus. Baits made up with red squill, which is not a poison under the Pharmacy and Poisons Act, 1933, are recommended, as such baits are comparatively harmless to other animals and human beings. The other poisons are dangerous and are subject to sale and other restrictions, under this Act. Red squill used as a liquid extract is an excellent poison. Bread is cut up into ½-inch cubes and soaked in the liquid.

Barium carbonate is a good poison, made up with 1 part of barium and 4 parts of bread-and-water paste. Cats are more susceptible to barium carbonate than rats in proportion to their body weight and might receive a lethal dose by eating a poisoned rat. It is claimed that if poisoned by arsenic in a similar way cats will vomit the meal and recover.

The baits should be about the size of a hazel nut. In laying baits or traps, great care should be taken to handle them as little as possible with the naked hand, as the rat quickly detects the smell of human beings. Mass poisoning of brown rats is comparatively easy, but the same methods often fail to produce the same results in the case of black rats.

Bacterial rat viruses. These usually contain some such organism as either *Danysz bacillus* or *Bact. enteritidis* (*Gärtner*) and are sold in gelatine cultures or liquid broth medium. Propagation of virus from rat to rat is feeble. The virus rapidly loses its virulence especially when exposed to light and air, and in time the animals develop immunity by the ingestion of amounts that are insufficient to kill, or of cultures that have lost their virulence. Rats are notoriously resistant to bacterial infection. As human infection has occurred, virus should not be used in such places as restaurants, kitchens or dairies.

Pre-baiting should always be carried out to ensure that the rats will take the poison baits. Unpoisoned food is put down at selected points late each day for three or four days, and the

rats, thus attracted, eat heavily of the poisoned material when substituted. This method is economical, as poison baits are not broadcast over areas which may not be visited by rats. The amount of poison bait required is approximately one-fifth of the maximum quantity of pre-baiting food consumed.

Trapping has the advantage that all rats caught can be counted and examined if necessary.

Break-back traps are very useful either baited or unbaited in certain circumstances. In badly infested buildings and offices a considerable number of these traps should be set simultaneously each evening, near the base of walls, behind cupboards and radiators, etc., They should be placed about 2 feet apart with the treadle ends towards the wall and about 6 inches to 1 foot away from it. They should not be placed too near the holes. Arranged thus, the traps are in the actual "runs" frequented by the vermin. Black rats are not as easily caught in these traps as the brown variety. Wire cage traps may be used baited with a variety of food, which should include tomatoes. The traps should be left open at both ends for a few nights to let the rats get accustomed to them. Lithographic varnish or rat-lime traps may also be used. The varnish is spread evenly over cardboard measuring 15 inches by 12 inches, leaving an inch margin all round. Bait is placed in the centre and the boards are set at night in the rat "runs," or near the rat holes. For mice similar cardboards 7½ inches by 12 inches are used and a margin of ½ to ¾ of an inch is left round the edge. The varnish traps should not be set in very hot rooms, in rooms where flour is much used, in damp or dusty situations, or out of doors. Varnish traps dry up after a few days and become useless. Such baits as pieces of fish, cheese, tomato, etc., may be used, and a change of bait is useful. (See Min. of Ag. and Fish. Bulletin No. 30, 1942).

Fumigation. All rat holes except one should be stopped with earth, and into the open hole the gas is introduced by a flexible tube; a hole high up is used for a heavy gas, one low down for a light gas. Any of the following gases may be used: sulphur dioxide, hydrogen cyanide, acetylene, or the exhaust gases from a motor-car which contain carbon monoxide. Sulphur dioxide may be released from portable cylinders fitted with control valves and nozzles to which rubber tubing is attached; for large-scale operations a Clayton generator may be used. (Min. of Ag. and Fish. Leaflet, No. 244, 1927.) In skilled hands cyanide fumigation is more efficient than sulphur dioxide, as a lower concentration is required. Calcium cyanide in powder form, known as "Cyanogas," is also used for rat fumigation. The dust is introduced with a powder blower, to which is attached a length of rubber hose. All exits, and finally the entrance hole,

are stopped with earth when the dust is seen to have penetrated the whole run. (See p. 228, Fumigation of Ships.)

Terriers and *ferrets* are useful for clearing infested barns and ricks. (See Rats Orders, p. 674.)

Preventive measures. 1. Removal of all waste matters and their rapid destruction. Metal refuse bins with tightly fitting lids should be used.

2. Proper protection of food: a stout wire-netting of not more than $\frac{1}{8}$-inch mesh is necessary.

3. Rat-proofing of buildings: concrete foundations, protection of all ventilating, etc., openings, proper construction and sealing of drains. A rat cannot climb round a smooth, horizontal ledge projecting 9 inches from a wall. It can jump on to a ledge 2 feet 6 inches from the ground but not over 3 feet.

4. Rat-proofing of ships. This falls under two headings: (*a*) the elimination type, which aims at the elimination of rat harbourages, applicable to new ships; and (*b*) the protective type, which aims at the closing of potential harbourages which cannot be removed. In general terms rat-proofing includes the effective closing of structural openings, the avoidance of dead spaces (*i.e.* hollow bulk heads, partitions, etc.), the use of fore-peak and after-peak spaces for tanks instead of for stores, painting alleyways a light colour with ample illumination, making bilges rat-proof, reducing air spaces in insulated walls to a minimum by isolating the galley and other heated spaces as far as practicable.

5. Prevention of landing of rats from vessels: 3-foot metal rat-guards should be fixed at right angles to the hawsers and maintained in a good state of repair; frequent tarring of ropes; painting upper one-third of gangway white and keeping it well lit. The ship may be breasted 4–6 feet from the quay, but as this increases the cost of unloading it should be adopted only in exceptional circumstances. (See *The Medical Officer*, 12th Dec., 1942, pp. 189–91; 19th December, 1942, pp. 197–98; 26th December, 1942, pp. 205–07; 31st July, 1943, pp. 37–38; 7th August, 1943, pp. 45–46, "Rodent Control in the Port of London," Morgan, M. T., Fisher, J., and Watson, J. S.)

The rat as a carrier of disease

A high proportion of apparently healthy rats are carriers of one or other of three species of parasites, without suffering any obvious injury from the infestation. Amongst ninety-eight brown rats caught in London there were forty-one carriers of *Trypanosoma lewisi*, three of *Leptospira icterohæmorrhagiæ* and one of both. The *Trypanosoma lewisi* is found in from 25 to 65 per cent. of rats examined in all parts of the world. It shows but little pathogenicity for any other animal. The third

parasite is the *Spirillum minus* (*Spirochæta morsus muris*), the organism of rate-bite fever.

(*a*) ***Rat typhoid*** (rodent typhoid) is a disease in many ways simulating human enteric fever, affecting rats, mice and other rodents. It is caused most frequently by *Bact. aertrycke* and by *Bact. enteritidis*—both members of the Salmonella group. The disease is widespread throughout the world, and, though usually endemic, it not infrequently flares up and gives rise to extensive mortality in the rodent population. The importance to man of rodent typhoid is that both the organisms causing it are capable of giving rise to acute gastro-enteritis ; they are, in fact, two of the commoner bacterial species met with in outbreaks of food poisoning. Made-up meat dishes are liable to become soiled in insanitary premises with the urine or fæces of infected animals, and in this way the organisms gain access to the human alimentary canal.

(*b*) *Rat plague*. This disease is endemic among rats which are the natural reservoir of infection. The *rattus rattus* or black rat is essentially the plague rat. At intervals the disease assumes epidemic form when it may be followed by an outbreak of bubonic plague in man (see p. 120).

(*c*) *Leptospirosis* (Weil's Disease) is a severe form of infective jaundice caused by the *leptospira icterohæmorrhagiæ* (see p. 132).

(*d*) *Rat-bite fever* is due to the *Spirillum minus* (*Spirochæta morsus muris*). The disease is fairly common in Japan, but cases have been reported in this country and elsewhere. The condition may often be severe, and is due to the actual bite of the rat. The wound heals, and then, after a varying incubation period, shows signs of irritation ; this is accompanied by fever of an undulating type. Cases have been recorded where infection occurred after the bite of a cat which a short time before had been playing with a dead rat, and after the bite of a ferret while ratting. (*B.M.J.*, 17th December, 1932, Hickling.)

Trichiniasis is caused by eating the flesh of pigs containing the cystic stage of the *Trichinella spiralis* (see p. 180). The rat is suspected as a source of sporadic outbreaks as infected rats have been found in the neighbourhood of piggeries. Rats are cannibals and infestation, once acquired by them, is likely to persist from generation to generation. Pigs, on the other hand, require fresh doses of contaminated pig food (*e.g.* pork refuse either domestic or from a slaughterhouse) to maintain infestation unless from time to time they eat infected rats.

In recent outbreaks, caused by eating uncooked sausage meat, the main symptoms were œdema of the eyelids, headache, conjunctival hæmorrhages, fever, generalised aches and pains, muscular tenderness and lethargy, and in every case there was pronounced eosinophilia.

For diagnosis the skin sensitivity test may be used. This is positive during the second week and persists for a year.

Infection of man from pork can be prevented by cooking the meat at a temperature of 60° C., by refrigeration at − 15° C. for twenty days or by brine-curing; refrigeration at 0° C. must be continued for several months to be effective. Pickling and smoking, as usually carried out, are not safeguards.

Rats should be eliminated from farms and slaughterhouses, piggeries should be made rat-proof and, in accordance with regulations issued by the Ministry of Agriculture and Fisheries, all pig swill should be boiled before use. (U.S.P.H.S. Reports, Vol. 52, Nos. 16 and 17, 16th and 23rd April, 1937; Vol. 53, No. 33, 19th August, 1938; *B.M.J.*, 11th December, 1937, pp. 1162–65, Van Someran; 15th February, 1941, pp. 237–40, Lee, J. E. S.; also pp. 240–41, Garrod, L. P., and Maclean, D.; *Public Health*, March, 1941, pp. 88–91, Jolly, R. H. H.)

Tularæmia is a disease caused by *Bact. tularense* affecting mainly rodents—hares, wild rabbits, water voles, ground squirrels—as well as certain birds, *e.g.* grouse. Man is occasionally infected. It is widespread in the Western States of America, and has been found in various European countries and in Turkey. In rodents the disease resembles plague, and appears to be spread by blood-sucking insects, especially ticks. In man the disease is either of the glandular type with an ulcer at the site of entry (usually on the hand or the conjunctiva) or of the typhoid type. Illness lasts about three weeks but convalescence is slow. Mortality amounts to about 5 per cent. Human beings are infected either by ticks, mosquitoes or other biting flies or by the dressing of infected animals in the case of butchers, poultrymen and trappers. Many infections of laboratory workers have been recorded. In diagnosis the agglutination test is of value. (U.S.P.H.S. Reports, Vol. 52, No. 4, 22nd January, 1937; and Vol. 55, No. 16, 19th April, 1940.)

Brucellosis (Undulant fever) is a disease of indefinite duration, irregular course and low mortality. It is characterised by a series of febrile attacks, each lasting for one or more weeks and followed by a period of apyrexia of uncertain duration. Attention was first directed to the condition in Malta, where it was discovered that the infective organism *Brucella melitensis* (caprine type) was present in large numbers in the milk of goats. The disease became known as Malta or Mediterranean fever, and in 1906, when the consumption of unboiled goats' milk was forbidden to the naval and military forces in the island, the incidence fell at once among the troops. There is evidence that the infection may also be acquired by eating cheese made from the milk of infected goats. Outside the body the organism is fairly resistant; dried on cloth it may remain alive for seventeen days,

in dust for forty-four days and in sterile tap-water for twenty days. Other members of the brucella group are—*Brucella paramelitensis* found in North Africa; *Brucella abortus* (bovine type), formerly known as *Bacillus abortus* of Bang, which produces contagious abortion in cattle and undulant fever in man; *Brucella suis* (porcine type). It has been shown that there is a close relationship between *Br. melitensis* and *Br. abortus*. Human beings, goats and cattle are not by any means the only sources of the Brucella genus, for organisms of similar character have been isolated from sheep, pigs, horses, mules, dogs and other animals. A diagnosis is made from the patient's clinical condition, together with an agglutination test. In latent infections a titre of 1 in 80 and upwards is found, but during the manifestation of the disease a titre of 1 in 1,000 should be obtained. In a proportion of the cases the organism may be recovered from the blood or fæces, but it has been shown that in about 75 per cent. of patients it is found in the urine and may persist into convalescence. An intradermal test with abortin is now available. The disease has been recognised in practically every country in the world. In the United States of America the number of cases reported rose from 1 in 1922 to 1,545 in 1931 to 3,501 in 1939. In England and Wales 252 well-authenticated cases were reported between 1926 and 1934, but it is difficult to ascertain accurate information with regard to the actual number of cases that have occurred in this country and Wilson's estimate of 400–500 cases per annum seems no exaggeration of the true position.

Infection appears to be contracted in the great majority of instances by the consumption of raw milk (see p. 359), of other dairy produce as well as of ice cream, although infection by direct contact with infected animals, carcases, excreta, litter, etc., may occur. In laboratories the greatest care should be taken in handling cultures as infection may occur through contamination of the abraded skin or the conjunctiva with infective material. In Bristol *Br. abortus* has been demonstrated in 12 per cent. of milks marketed in the city (the figure is between 20 and 30 per cent. for the country generally), and the presence of agglutinins has been proved in from 22 to 44 per cent. of various milk samples (raw and pasteurised). It must be remembered that the presence of agglutinins does not imply the presence of *Br. abortus* itself. In the same city out of 590 healthy persons tested 7 per cent. showed positive agglutination. It is advisable that all specimens of blood sent in for diagnosis in cases of continued fever should be submitted to the agglutination test for undulant fever. It might be possible to eliminate from herds all animals showing a positive reaction to the agglutination test, but this would be an expensive undertaking. Any risk to the public may be

avoided by pasteurisation of milk in accordance with the conditions laid down in the Milk (Special Designations) Regulations (see p. 612). The Ministry of Health has expressed the opinion that the discovery of *Br. abortus* in milk is evidence of an "infection of the udder or teats which is likely to convey the disease." The Food and Drugs Act, 1938, makes it an offence to sell milk from a cow suffering from such an infection and a local authority may therefore take appropriate action (see p. 586). (Ministry of Health Report, No. 56, 1929; *Proc. Roy. Soc. Med.*, Section of Epidemiology, June, 1933, pp. 99–112; *J. Hyg.*, Vol. XXXIV., June, 1934, p. 242, "Sources of Infection in Undulant Fever," Smith; *Lancet*, 6th August, 1938, pp. 326–328, "Undulant Fever," Dalrymple-Champneys; *B.M.J.*, 23rd March, 1940, p. 477, "A Mild Epidemic of Undulant Fever in a Boys' School due to Drinking Raw Milk," Elkington, G. W., and others).

Anthrax affects mainly the ungulates, although probably no class among the mammalia is completely immune. In animals, anthrax is practically always gastro-intestinal in type, the result of infected pastures or infected grain and cake food. The period of obvious illness is short. In man, infection may be contracted as a result of manipulation of any material derived from an infected animal, the chief sources of danger being skins and hides, wool, hair, bristles and bone meal. Shaving brushes have been proved to be the medium in several instances. As the bacilli produce their spores only in the presence of free oxygen, the conditions necessary for spore formation are supplied whenever the blood or discharges from an infected animal come in contact with the air. The spores may remain alive for years.

Among workers in wool, hides and hair, three manifestations of the disease may occur: (*a*) malignant pustule or cutaneous anthrax, (*b*) gastro-intestinal anthrax, (*c*) pulmonary anthrax. An analysis of 528 cases of industrial anthrax reported to the Factory Department of the Home Office from 1921 to 1936 inclusive shows that 235 cases were infected from wool, 206 from hides and skins and 59 from horsehair; "malignant pustule" was the type of disease noted in 516 cases and pulmonary anthrax in 9; the head and face were involved in 210 cases, the neck in 140 and the upper extremity in 147. The incubation period of the cutaneous form is about twenty-four hours. Early diagnosis and effective treatment have considerably lowered the mortality. Statistical evidence is available proving that, when the cases were treated by a practitioner having special knowledge of anthrax, diagnosis was made twenty-four hours earlier than in those seen by other practitioners. The best treatment for anthrax is physiological rest of the part affected, combined with intravenous or intra-

muscular injection of anti-anthrax serum. Excision is practised only in the worst cases. The usual dose of serum is 60 c.c., followed in twelve hours by repeated doses of 20 to 40 c.c. Salvarsan may be used if serum is not available. Recently a combination of serum and M & B 693 has been found to give satisfactory results. The table below shows the results of treatment in 516 cases of cutaneous anthrax. In internal anthrax death usually supervenes on the third to the fifth day of the disease, sometimes earlier. (*B.M.J.*, 8th July, 1933, pp. 50–53, Eurich.)

Infected wool and hair appear to come principally from India, Central Asia, Persia and Mesopotamia, Asia Minor, Egypt and Russia. All materials from Central, Southern and Western Asia and Egypt should be classed as dangerous. Blood-stained

RESULTS OF TREATMENT IN CASES OF "MALIGNANT PUSTULE," 1921–1936

Treatment given	Number of cases	Recovered	Per cent. recovered
Serum only	301	275	91·3
Excision only	24	20	83·3
Excision and serum	114	107	93·8
Serum and arsenical preparations (N.A.B., stabilarsin, etc.)	29	26	89·7
Stabilarsin alone	1	1	100·0
CO_2 snow	1	1	100·0
No "specific" treatment	12	1	8·3
Spontaneous cure	1	1	100·0
Not stated	33	28	84·8
Total	516	460	89·1

material is always more to be dreaded. All cases occurring in factories must be notified to the Chief Inspector of Factories.

Under the Anthrax Prevention Act, 1919, Orders in Council may be issued prohibiting the importation into Great Britain, either absolutely or except at specified ports and subject to specified conditions, of goods infected or likely to be infected with anthrax. In 1921 Orders prohibited the importation of all goat hair and of wool or animal hair from Egypt, except at the Port of Liverpool, where on arrival they are taken charge of by H.M. Customs and transferred to the Government disinfecting station for disinfection. At Liverpool the "Duckering" process of disinfection is in operation. The plant consists of (1) a feeding machine for opening bales and feeding the material without personal handling, (2) five successive baths, each having harrows for propelling the wool through

the solutions and rollers for removing excess liquid from the material, (3) a drying machine, (4) a cooling machine and (5) a baling machine.

"The process consists of exposure of the material for ten minutes in each case to solutions, each at a temperature of 102° F., contained in five baths in succession, as follows: (1) 0·5 per cent. solution of sodium carbonate to remove the albuminous coating of the spores; (2) 0·5 per cent. solution of soap containing a small proportion of free alkali which has the effect of bringing the spores into a condition in which they are more easily destroyed; (3) 2 per cent. formaldehyde solution; (4) 1·9 per cent. formaldehyde solution; (5) clean water for the purpose of removing excess formaldehyde from the wool. The material then passes automatically through the drying, cooling and baling machines." (Annual Report, Chief Inspector of Factories, 1932, pp. 76–81.) The process is controlled both by routine chemical examination of the solutions and by routine bacteriological examination of the materials before and after disinfection. A considerable quantity of material other than that required by the Order of 1921 has been voluntarily sent to the station for disinfection. Such horse hair as is not capable of being disinfected by the "Duckering" process should be treated by steam under pressure for at least half an hour. Hides may be steeped in a mixture of 1 per cent. crystalline sodium sulphate and 1·2 per cent. lime at 90° F. for eight days, and then at ordinary temperature for another four days—no method which is both bactericidal and commercially satisfactory has, however, so far been evolved.

The following method of disinfecting shaving-brushes was suggested by the Ministry of Health:—

The brush should be—

(*a*) thoroughly washed with soap and warm water containing a little washing soda and then allowed to stand for half an hour in warm water containing a little soda;
(*b*) placed in a warm solution of formaldehyde (1 part of 40 per cent. formalin and 16 parts of water—a 2½ per cent. solution of formaldehyde) for half an hour;
(*c*) allowed to dry.

This method does not, of course, affect spores embedded in the handle of the brush.

Most infected shaving-brushes came from Japan. An order was issued in 1920 prohibiting the further importation of Japanese shaving-brushes.

Precautions are also taken in factories, and include exclusion of workers suffering from skin lesions, wearing of overalls, sufficiency of washing accommodation, damping bales of hair, etc., to keep down dust, and localised exhaust ventilation. In

1941 twenty-two cases of anthrax (including three fatal cases) were notified to the Chief Inspector of Factories.

By the Anthrax Order, 1938, the M.O.H. must be notified by the inspector under the Diseases of Animals Acts if a case of anthrax in an animal arises in his district. He is usually expected to advise on the question of disinfection. The Order requires the carcase to be destroyed by burning, either on the farm or on other suitable premises (usually in the nearest destructor). If the carcase is to be removed, it must first be disinfected and all natural openings must be plugged with tow soaked in strong disinfectant. If cremation is impracticable, the carcase must be buried at least 6 feet below the surface of the ground and surrounded on all sides with a layer of not less than 1 foot of quicklime. The site of burial must be removed from any dwelling-house or water supply and be in a place to which cattle will not have access. In no case must the skin be cut prior to destruction of the carcase save by a qualified veterinary surgeon for the purpose of diagnosis (sample of blood usually taken from an ear). Thorough disinfection of the cattle-shed, and utensils, vans, etc., in any way contaminated, must be carried out. By these means indigenous anthrax has been practically stamped out in this country.

Leptospirosis (Weil's Disease) occurs, particularly, among troops in barracks, sewer workers and miners. It is primarily a disease of rats, and human infection occurs chiefly through mud, slime and water contaminated by the urine of the diseased animals. In one series of 56 cases the incubation period averaged from nine to ten days. The leptospira enters the human body through abrasions of the skin or mucous membrane. In this country most of the cases have been reported among sewer workers, and the disease, if confirmed by bacteriological or serological examination, now comes under the Workmen's Compensation Acts. Sewer workers should be warned of the risk of having exposed cuts or scratches. Diagnosis depends in most circumstances on serological investigation. It is often impossible to differentiate Weil's Disease from infective hepatitis on clinical grounds and only rarely are leptospira seen in the blood or isolated by culture or guinea-pig inoculation during the first few days of the disease. The patient's work may often give a clue to the disease which is confirmed by the blood picture and by the agglutination test. Leptospira may be recovered from the urine especially during the third week, and the urine may remain infective for as long as forty days. Control of the disease requires reduction of the rat population by every means especially where individuals have contracted infection. Foodstuffs, such as offal, should be deposited in metal bins and when possible the premises made rat-proof. In tripe and fish factories the premises and benches should be washed down each

morning with running water to which might be added a weak solution of hypochlorite disinfectant. Protective rubber boots and clothing should be worn and facilities for washing and disinfection provided. If these measures are not sufficient to control infection, then active immunisation should be tried. (*B.M.J.*, 18th February, 1939, pp. 324–26, Stuart, R. D.; 25th March, 1939, pp. 603–605, Rees, W. E., and pp. 605–607, Sladden, A. F.; 26th June, 1943, p. 783, Broom, J. E., and Brown, H. C.).

Glanders and farcy rarely affect man. The condition may be either acute or chronic, and in either case the mortality is high. It is met with in horses, mules and asses, and a horse may carry the *Pf. mallei* without showing any symptoms. Diagnosis is made in doubtful cases by injection of mallein. The inspectors of the local authority must notify the M.O.H. on becoming aware of a case in the district. The disease may be controlled among horses by quarantine of all imported animals till they are proved free from the condition, slaughter of the infected, avoidance of common drinking-troughs, and complete disinfection of infected stables.

Rabies is a disease to which all warm-blooded animals are susceptible. In the huge majority of cases it affects dogs, but cats, horses, cattle, foxes, deer, pigs, and sheep may also suffer. The condition in man is known also as hydrophobia. A paralytic type of rabies has been shown in Trinidad to be transmitted to human beings by vampire bats. (*Trans. R. Soc. Trop. Med. and Hyg.*, Vol. XXIX., No. 4, 1936, p. 317, de Verteuil and Urich.) In dogs the "furious" form usually manifests itself. Towards the end paralysis sets in. In rabbits the "dumb" or paralytic type of disease is always found. The virus, which is supposed to be a filter-passer, is found constantly in the saliva, salivary gland, brain and spinal cord. It is occasionally present in the peripheral nerves, lachrymal gland, pancreas and milk. It is never found in the blood, lymph or urine. Diagnosis is made chiefly by the finding of Negri bodies in the cells of the cornu ammonis of the hippocampus major or in the Purkinje's cells of the cerebellum. These bodies are considered to be most probably cellular changes brought about by the virus, and are found in at least 95 per cent. of rabid dogs examined. They are also found in the human brain in cases of hydrophobia. Subdural inoculation into a rabbit of an emulsion of the cord of a dog dead of rabies is the most certain method of diagnosis. The disease is communicated always through a bite or through deposition of saliva, *e.g.* by licking, on an abraded skin. The virus is also capable of passing through an uninjured mucous membrane. The saliva of the dog may be infective as long as five days. Bites on the head, face or neck are the most dangerous, as the

virus has only a short distance to travel along the nerves before reaching the brain. Cauterisation, thoroughly performed within half an hour of the bite, will prevent hydrophobia in many cases, but is no good after twenty-four hours. Pure carbolic acid, izal, lysol and iodine may be swabbed into the wound and subsequently washed out. When a person is bitten by a suspected dog, the dog should be kept under observation for a period of ten days. If the dog develops rabies after that, the individual bitten has nothing to fear, as the saliva of the dog is never virulent ten days before the disease manifests itself. If the dog develops rabies within the ten days, antirabic treatment of the bitten person should be undertaken at once. If, however, the bite has been inflicted on the head, face or neck, treatment should be given immediately in an infected district, if the dog was a stray one. Three main types of antirabic vaccine are at present used: (1) attenuated virus vaccine; (2) live virus vaccine, and (3) killed virus vaccine. In comparing the actual value of these three types no marked advantage is claimed for any one of them, but the killed vaccine does not require personal attendance of the patient at the antirabic institute. As prepared in Kasauli, this vaccine consists of sheep's brain fixed virus killed by phenol, and when stored under suitable conditions it will retain its antigenic activity for several months. The vaccine can be put up in sets of sealed ampoules suitable for the inoculation of individuals according to the class of bite, and these can be dispatched to various centres and held available for immediate use. Should a dog be destroyed after biting a human being, the brain should be sent to a central laboratory for diagnostic purposes. The brain of a rabid animal is highly infectious, so great care must be exercised by the person doing the post-mortem operation. One half of the brain should be placed in 10 per cent. formalin and the other in 50 per cent. glycerine in sterile water.

In man the disease appears most frequently in the second or third month after infection, rarely after the sixth month. The nearer the bitten area is to the brain, and the more severe the bite, the shorter is the incubation period. It has been estimated that from 16 to 60 per cent. of the cases bitten developed hydrophobia prior to the use of Pasteur's treatment. Among 52,895 persons who received antirabic treatment at the Pasteur Institute of Paris, between 1886 and 1938 there was only 0·28 per cent. of failures. At the Pasteur Institute of India, Kasauli, more than 22,000 cases were treated during 1938 with a mortality of 0·33 per cent.

The principal measures for the prevention of rabies in dogs are: (1) application of the Rabies Order, 1938, issued by the Minister of Agriculture and Fisheries; (2) restriction of the movement of dogs; (3) quarantine of all imported dogs for a

fixed period, under the Importation of Dogs and Cats Order, 1928, made by the Minister of Agriculture and Fisheries. *Bull. Health Org. League of Nations*, Vol. 9, No. 1, 1940, pp. 31–78, "Statistics on Rabies," McKendrick, A. G.; "Rabies," Webster, L. T., Macmillan Co., New York, 1942).

Psittacosis is a disease mainly of parrots, parakeets, budgerigars and similar birds, characterised by diarrhœa, shivering, discharge from the eyes and beak and listlessness. It is not confined to the parrot family and virus of pigeon origin may infect human beings. The infection may occur among birds in the wild state or in aviaries. Budgerigars, in particular, tend to suffer from subclinical attacks and may become apparently healthy carriers of the infection. In 1929–30 cases of psittacosis began to be noted in human beings in various parts of the world, the symptoms resembling those of typhoid fever often complicated by pneumonia. The incubation period is usually six to fifteen days, and infection is due to inhalation of particles of beak discharges or excreta from birds suffering from the disease, case to case infection being rare. Case mortality among human beings may be as high as 20 per cent. The causal agent is a virus and the laboratory diagnosis of the disease is dealt with in the Ministry of Health Report, No. 80, 1937. Sturdee and Scott discussed the ætiology, clinical features and pathology of the condition in the Ministry of Health Report, No. 61, 1930. An account of an outbreak of psittacosis at the London Zoological Gardens appeared in the *B.M.J.*, 14th January, 1939, pp. 51–55, Troup, A. G., Adam, R., and Bedson, S. P. The importation of parrots and similar birds is prohibited by regulations issued in 1930 (see p. 650).

Actinomycosis is not a common disease in man, though fairly widespread in cattle and less so in horses and swine. Males are said to suffer more than females and the incidence is higher among agriculturalists than among workers in other occupations. Frequently the condition is mistaken for tuberculosis of the bone, lungs, peritoneum, etc. It is now generally concluded that the infection is at least usually autogenous. The old idea that actinomycosis resulted from chewing straw or grain arose from a confusion between two plainly distinct micro-organisms, of which that found in grain has no claim whatever to be considered pathogenic to man. In some cases there has been a history of dental extraction immediately preceding the onset of actinomycosis of the jaw, and trauma may be a frequent additional factor accounting for the onset of the disease in the mouth. There seems little reason for retaining the term *Actinomyces bovis* for the human type for which the name *Actinomyces israeli* is suggested. Although preponderantly of human origin it may occur elsewhere, notably in swine and occasionally in cattle. Anaerobic strains similar to *Actinomyces*

israeli have been discovered in normal mouths. (M.R.C. Special Report No. 240, 1940.)

Ringworm may be caused by two distinct types of parasite, one of which is the *Microsporon audouini* and the other is the *Trichophyton*. Ringworm may occur either on the scalp or on the body; in the former case it is usually caused by the *Microsporon audouini* and in the latter by the *Trichophyton*. Ringworm of the scalp is less severe in older than in younger children as the hairs become more resistant. On the head it presents a dry scaly patch on which is found broken hairs. Both teachers and school nurses should always be on the look-out for this condition, especially in infant schools, and hairs from a suspected case should be sent for microscopic examination. No child should be re-admitted to school till after careful examination at the school clinic. Home contacts should always be inspected as sometimes a child under school age may be found to be infected.

A simple method of detecting hairs which are affected with ringworm consists of dabbing the diseased patch with a piece of wool soaked in chloroform. On evaporation the affected hairs are whitened as though covered with hoar-frost. Hairs affected with favus are not similarly whitened. The diagnosis of the disease has been much facilitated by the use of ultra-violet rays. If the light from a mercury vapour lamp be made to pass through a screen of Wood's glass (*i.e.*, glass containing nickel oxide) before being thrown on an infected scalp, the diseased hairs fluoresce brilliantly. Vaseline and other ointments produce somewhat similar fluorescence. The best treatment is by means of X-rays, and this treatment may be applied to all children save those under one year of age. The average period of exclusion from school need not be more than thirty days. All the hair should have fallen out by the twenty-first day, and any obstinate stumps should be removed by hand. The hair should begin to grow again about the eighth week, and re-growth should be complete in about six months. The child should return to school when all the hair has fallen out and should wear a linen cap. Thallium acetate, taken internally in a dose of 8·5 mg. per kilogram of body weight, is another form of treatment. The hair should fall out as a result of this treatment in three to four weeks. The method is not without danger and is not recommended by the Board of Education. In rural areas where X-ray treatment may be difficult to obtain, the child's hair must be cut short, appropriate ointments (*e.g.*, calomel and iodine) applied and a linen cap worn, and in such circumstances affected children may be allowed to attend school.

Ringworm of the body may affect the face, neck, arms, etc. It appears at first as a red patch the centre of which clears

leaving a ring from which the condition gets its name. It usually clears up after one or two applications of iodine.

Athlete's foot is a form of ringworm and in one university in the United States it was found that out of 3,100 entrants in one session 53·3 per cent. of the men and 15·3 per cent. of the women had foot ringworm. It is probable that infection is picked up by the toes from the floors of bathrooms, swimming baths and changing rooms, and it has been suggested that the employment of rubber shoes in swimming might be made compulsory. The condition is often difficult to cure and is apt to recur. Whitefield's ointment or fuchsin paint often gives good results. (See also p. 280).

Tetanus. The *Cl. tetani* is an anaerobic organism whose natural habitat appears to be the alimentary tract of horses, cows, etc. For symptoms to be produced the bacilli or their spores must be inoculated through a skin wound. If pyogenic organisms are present at the same time, a condition favourable to anaerobic growth is established, and the tetanus bacilli and spores will multiply and develop the powerful toxin which alone is absorbed into the nervous system and accounts for the clinical picture of tetanus. The spores are constantly present in manured land, such as was found generally in Flanders during the War (1914–1918), and in the dust of cities. Some areas always contribute more cases than others. The tropics show a higher incidence than temperate climates. In soil the spores do not multiply, but their resistance is great. Tetanus neonatorum used to occur frequently in the days when aseptic precautions were not adopted in ligature of the cord. Thorough cleansing of wounds and prophylactic injection of antitoxin will suffice to prevent the disease. To induce active immunisation against tetanus the following preparations have been tried: tetanus toxoid-antitoxin floccules, tetanus toxoid (Ramon's anatoxin) and alum-precipitated tetanus toxoid. Of these tetanus toxoid is now used for immunisation in the Army, two subcutaneous injections of 1 c.c. being given at intervals of six weeks; reactions are extremely rare. The protection is said to last for many years. The normal prophylactic dose of tetanus antitoxin is 3 c.c. which is equivalent to not less than 3,000 International Units, and it should be given by intramuscular or deep subcutaneous injection. Every wounded person, however trivial the wound, should be given an initial dose of 3 c.c. No reduction in the dose should be made in the case of children and the same initial amount should be given whether the patient has been immunised with tetanus toxoid or not. Two further doses of 3 c.c. should be given at weekly intervals to all patients not immunised with tetanus toxoid, and, in the case of severe wound infection, these doses should be increased to 6 or 9 c.c. ("A Study of Sixty Cases of Tetanus," *Amer. J. of Surgery*,

September, 1940, pp. 480–83, Kirtly, J. A., Jr.; *B.M.J.*, 28th December, 1940, pp. 891–95, Marvell, Doris M., and Parrish, H. J.; *J. Roy. Inst. Public Health and Hygiene*, January, 1941, pp. 7–36, Harben Lectures, Bensted, H. J.; *Bull. War Medicine*, September, 1942, p. 8).

Tetanus has at times occurred after vaccination against smallpox. The use of shields and dressings, especially in the case of primary vaccination with large scarifications, appears to predispose. (Reprint No. 1195, U.S.P.H.S. Reports, 16th December, 1927.)

Trachoma (Granular Conjunctivitis). This disease is responsible for much blindness in countries where it is endemic. Both eyes are usually affected. It is rare in England but is sometimes found among such communities as the poorer classes of aliens, especially when living under crowded conditions in unhealthy dwellings. It is usually very chronic, and a permanent cure is either doubtful or most difficult. There is marked irritation, photophobia and lachrymation with mucopurulent discharge. It is spread by means of the fingers, towels, handkerchiefs, etc. As the disease flourishes where sanitary conditions are worst, its control consists of scrupulous cleanliness, the elimination of foci where they are present, and the improvement of both personal hygiene and sanitation of the community in general.

Leprosy is still a very widespread disease. In this country cases are reported from time to time (*B.M.J.*, 17 Jan., 1925, p. 107, MacLeod), but it is very unlikely that infection is conveyed from one such case to another. The number of imported cases is small, and the control of the disease cannot therefore be looked on as a public health problem. There is a small leper colony in Essex. Leprosy is a disease mainly of tropical and sub-tropical countries. Its prevalence is difficult to ascertain, but surveys in India have shown an incidence of from 1 to 10 per 1,000 of the population, although the census figure is only 0·42. The disease is due to the *Myco. lepræ*, which closely resembles the *Myco. tuberculosis*. It is now generally accepted that hereditary transmission has not been proved. Children are more susceptible to leprosy than adults, but those under five less often show evidence of infection as the incubation period averages from two to three years. The disease is liable to manifest itself about the age of puberty, males being more frequently affected than females. Children born of leprous parents should be removed soon after birth, as at the age of six months it may be too late to prevent the disease. The actual mode of infection is not yet known, but in all probability the bacilli from lesions and nasal secretions of advanced cases enter the skin of persons living in close contact, abrasions and insect bites so common in hot climates providing avenues for infection. The disease

is most prevalent among primitive people where overcrowding and a lack of cleanliness prevail, and here the value of education and propaganda cannot be overestimated. As a prophylactic measure compulsory segregation is not advocated, as it leads to the concealment of early curable cases. The following alternatives are suggested :—

1. The isolation of advanced cases on a voluntary basis in hospitals or colonies, where treatment is provided. As those giving negative bacteriological results are discharged, admission is sought. When children are born of leprous parents they are at once removed to a separate part of the colony, or sent to the homes of healthy relatives.

2. The examination of early cases by a board of experts. Those found not to be discharging bacilli are treated as out-patients, with the result that a number never reach the infective state.

3. The thorough examination of a household in which a case has occurred with a re-examination every six months for a period of five years. This procedure is based on the assumption that 80 per cent. of infections are house infections, and that in 80 per cent. of cases the incubation period is less than five years. If cases are treated in the early stages of the disease good results sometimes follow the administration of chaulmoogra oil and its ethyl esters as well as of sodium hydnocarpate. Alepol is cheaper than the ethyl esters and a 3 per cent. solution can usually be given subcutaneously or intramuscularly without causing pain, and 1 per cent. solution intravenously. These drugs may be given intramuscularly, subcutaneously, intradermally or orally. Whatever form of treatment is adopted, the patient must live under the best possible hygienic conditions with plenty of good food and outdoor exercise, for the disease cannot flourish in good hygienic surroundings. (League of Nations Report on the Study Tour of the Secretary of the Leprosy Commission, 1930, and "The Principles of the Prophylaxis of Leprosy," First General Report of the Leprosy Commission, 1931.)

Cancer. In 1939, out of a population of 41,246,000 in England and Wales, 68,981 persons died of cancer, 13·8 per cent. of all deaths being due to this disease. In 1942 the corresponding figure was 14·6. The death rate from cancer has gradually increased from 0·32 per 1,000 living in 1851–60 to 1·12 in 1911–20, and to 1·7 in 1942. Even when allowance has been made for the fact that the proportion of middle-aged and elderly persons in the population is greater now than formerly, the increase is still a real one, the recorded mortality from cancer having trebled itself in the space of two generations. There is little doubt that improved diagnosis and more accurate certification of cause of death have accounted

for part of this increase, but only part. Superficial cancers, such as those of the tongue and of the female breast, were readily recognisable as such even sixty years ago. Yet in the twenty-year period 1901–21 (after making allowance for the ageing of the population) the mortality of males from cancer of the tongue increased from 38 per million living in 1901 to 53 in 1921, and that of females from cancer of the breast from 148 in 1901 to 180 in 1921—increases of 39 and 28 per cent. respectively in twenty years. During the same period the mortality of the total population from all forms of cancer increased by 20 per cent. There is only one part of the body frequently attacked by cancer, the uterus, in respect of which a significant increase in mortality was not recorded during these twenty years—a fact which may in some degree be attributed to the fall in the birth rate. At the same time, during this period the general death rate, the infant mortality rate and the death rate from tuberculosis showed marked declines. An increase of mortality from cancer is the common experience of modern civilisation. In this country the tendency is for deaths from cancer to occur in later life than formerly, the greatest increases being shown, in the case of males, over forty-five years of age, and in the case of females, over sixty years of age.

More women than men die of cancer: in 1940 the numbers were 36,931 and 34,061 respectively (36,133 and 34,276 in 1942). Since 1924, however, the standardised death rate from cancer for males has exceeded that for females, and in 1940 these rates were 1,063 and 920 per million respectively. The excess in females is entirely due to malignant disease of the breast and generative organs; in most other parts of the body a considerable excess is recorded for males. Cancer of the uterus is more fatal to married or widowed, and cancer of the breast and ovary to single women. Cancer of the uterus accounts for 13·3 per cent. of all female deaths from cancer, and cancer of the breast for 20·1 per cent.

Liability to cancer is not an attribute of any particular social class, profession or occupation. Hereditary predisposition has not at present been proved to be of any practical importance in man. There is no scientific evidence that the use of any particular article of food increases the liability, nor will any known drug or preparation prevent the appearance of cancer or cure it when present. (Ministry of Health Report, No. 36, 1926, "Diet and Cancer, with special reference to the Incidence upon Certain Religious Orders," Copeman, S. M., and Greenwood, M.) No danger of cancer has been proved to result from inhabiting houses or districts in which cancer happens to have been exceptionally common, nor can it be said that cancer is infectious or contagious.

One certain fact about cancer is that it frequently follows on

chronic and prolonged irritation. Some tissues are more susceptible than others in this respect—*e.g.*, the skin of the face, the lips, insides of cheeks, tongue, lower part of bowel, neck of womb. A clay pipe, a jagged tooth or a badly fitting denture may be the source of irritation. Workers in tar, aniline or paraffin, chimney-sweeps and mule-spinners are apt to suffer from cancer in special parts of the body, *e.g.*, the scrotum, as a result of repeated irritation. Twort and his fellow-workers in Manchester have shown that it is possible to specify, in terms of refractivity and specific gravity, the physical characters which mineral oils should possess in order to reduce their carcinogenic properties. A mixture of anhydrous lanolin and olive oil applied to the scrotal area helps to reduce the risk in the case of mule-spinners.

Under the Cancer Act, 1939 (see p. 564), local health authorities may undertake propaganda work, such as the issue of leaflets on cancer or the giving of instruction at welfare centres, more particularly with regard to the necessity for the early diagnosis and treatment of all doubtful conditions. Such work must, however, be performed with great caution. Local authorities may also help by improving the local facilities for clinical consultations and for pathological examinations within their areas, and perhaps even by improving the local facilities for treatment by operation, by X-rays or by radium. It has been estimated that a hospital of less than about 300 beds does not receive enough cancer patients to enable adequate radiation equipment to be kept fully occupied. It appears that some 45–50 per cent. of the cancer patients admitted to hospital are affected in " treatable " organs. In certain of the larger county boroughs local committees have been formed for the study of cancer problems. These committees are composed mainly of local medical men, and their object is to collect local information and to decide on the local need for educative action. (See Annual Report, C.M.O., Ministry of Health, 1936, pp. 111–131.)

The value of early diagnosis and prompt treatment is illustrated by the following facts selected from Ministry of Health reports. The average duration of life of women suffering from cancer of the breast which has followed a natural course is little more than three years. On the other hand, with the complete modern operation 52 per cent. of cases were alive and well after three years, 39 per cent. after five years and 30 per cent. after ten years. These patients were in various stages of the disease. If the operation had been performed before the disease had extended beyond the breast, 94 per cent. of cases were alive and well after three years, 91 per cent. after five years and 87 per cent. after ten years. The average duration of untreated cases of cancer of the uterus is less than

two years, whereas after modern operative treatment the proportion of cases surviving after five years was on the average 40 per cent. With treatment by radiation about 10–12 per cent. of cases classed as inoperable survived for at least five years, and operable cases showed the same after-results as those treated by operation (40 per cent. survival after five years). In cancer of the skin, modern methods of radiation should obtain approximately 100 per cent. survivals, the actual figure being in the neighbourhood of 80–90 per cent.

(Ministry of Health Memoranda on Cancer, Circulars Nos. 426, 476, 496, 516, 716, 826, 1136, 1186, 1276 and 1813. See also Medical Research Council, Special Report No. 99, 1926, and Ministry of Health Reports, Nos. 28, 32, 33, 34, 36, 40, 46, 47, 51, 59, 66, 70 and 79.)

Goitre. Enlargement of the thyroid in England and Wales is prevalent in an area extending from Cornwall through Somerset into Northamptonshire, thence northwards through Derbyshire into Cumberland, West Durham and Northumberland. There are extensions from Wiltshire to the Isle of Wight, through Hereford to South Wales and through Cheshire to North Wales.

In a survey made by the Board of Education in 1924, which dealt with 375,000 children aged 12 years, 5·26 per cent. of boys and 13·33 per cent. of girls were found to be affected in areas of high prevalence, and 1·49 per cent. of boys and 4·41 per cent. of girls in areas of low prevalence. The condition is less prevalent in towns than in rural districts and, as a rule, in coastal than in inland towns. The distribution of endemic goitre in England corresponds roughly with the geographical distribution of fluorine and with the distribution of human dental fluorosis. Endemic goitre occurs in many parts of the world, notably in the Rocky Mountain States, the Great Lakes Basin and the Appalachian Mountain region in the United States, in parts of Canada, New Zealand, Switzerland, Poland and elsewhere in Europe.

Simple goitre is not in itself a serious condition but is very frequently a sign of some underlying constitutional disturbance. It is generally accepted that a deficiency in the iodine intake is responsible for simple thyroid enlargement. The unavoidable deficiencies in diet towards the end of the 1914–18 war were the apparent cause of an increase in the incidence of simple goitre in this country, and it is possible that history will repeat itself. Iodine is a constituent of many foods, notably fish, and of most water supplies.

The administration of iodine in goitrous areas has been shown not merely to prevent simple goitre but also to diminish the incidence of secondary thyrotoxicosis. Iodine is given usually in the form of iodised salt in amounts varying

generally from one part of sodium or potassium iodide per 100,000 to 5,000 parts of salt. Good results have been recorded from areas where this method has been tried and no ill effects have been reported. (Trans. Third Internat. Goitre Conference and the Amer. Assoc. for the Study of Goitre, 1938.)

An interesting discussion on goitre in Derbyshire will be found in the *Proc. Roy. Soc. Med.*, Epidem. Sect., July, 1933, pp. 1224–1266, Turton.

OCCUPATION AND HEALTH

Factory legislation began in England with the Health and Morals of Apprentices Act, 1802, which was a somewhat belated and not very successful attempt to remedy some of the more glaring evils that resulted from the uncontrolled employment of pauper children in industry. During the greater part of last century slow but sure progress was made in raising the age at which children could be employed and in reducing their hours of work. Young persons under sixteen years soon became "protected" in their turn, and in 1844 women were included with young persons in regard to limitation of hours of work. In the same year certifying factory surgeons were appointed to certify the age of children seeking employment in factories—certificates of fitness were not required till 1874. In 1847 the daily hours of women and young persons in textile factories were limited to ten. At first only workers in the textile trades benefited from these measures, but by 1867 the various Factory Acts had been extended to many other trades. It is interesting to note that except in certain dangerous industries and under the Mines Acts adult male labour has remained unregulated. The early Factory Acts initiated the system of compulsory education in England; by the provisions of the Act of 1833 children between the ages of nine and thirteen who were employed in factories were obliged to attend school for two hours on six days in the week. This "half-time" system of education lasted till 1920.

In 1833 the first inspectors of factories were appointed and made responsible to the Secretary of State; prior to that date the enforcement of the existing legal requirements had been entrusted to "visitors" appointed by the justices of the peace. The system of Home Office factory inspection has been greatly extended since those days. In 1878 a Chief Inspector of Factories was appointed, women inspectors were introduced in 1893 and in 1898 the office of medical inspector was created. The Factory Department of the Home Office * has always been responsible for the supervision of factories, which were defined

* At present controlled by the Ministry of Labour and National Service.

in 1878 as "premises wherein articles are made, secured, repaired, ornamented, finished or adapted for sale by means of manual labour, for gain, if mechanical power is used on the premises." The administration of workshops, *i.e.* premises where similar work was done but where no mechanical power was used, was placed in the hands of local sanitary authorities in 1867, transferred to the Home Office in 1871 and retransferred to the local authorities in 1891.

Legislation requiring the fencing of machinery was first introduced in 1844, and in 1864 every factory was required to be ventilated in such a manner as to render harmless, so far as practicable, any gases, dust or other impurities generated in the process of manufacture that might be injurious to health. Removal of dust by mechanical means became a legal requirement in the Factory Act, 1867. In 1891 power was given to the Secretary of State to certify that, in his opinion, any machinery or process in a factory or workshop was dangerous or injurious to health, or dangerous to life or limb, either generally or in the case of women or children, or any other class of persons; or that the provision for the admission of fresh air was not sufficient; or that the quantity of dust generated or inhaled in a factory or workshop was dangerous or injurious to health. The Chief Inspector could then propose special rules for a factory or workshop or the adoption of special measures. In 1901 power was given to the Secretary of State to make regulations in place of these special rules, and large numbers of these regulations are in operation at the present time. In 1891 the employment of women within four weeks after childbirth was prohibited in factories and workshops, and in 1895 every medical practitioner was required to notify to the Chief Inspector of Factories cases of poisoning from lead, phosphorus or arsenic or anthrax, contracted in any factory or worshop (see p. 145). An excellent summary of the development of factory legislation and administration during the past 100 years will be found in the Annual Report of the Chief Inspector of Factories and Workshops for the year 1932.

Of the 15¾ million persons in Great Britain and Northern Ireland insured under the Unemployment Insurance Acts in 1939, about 8 million came under the Factories Act, 1937, which is the chief relevant enactment. (See pp. 657–672). Similarly the chief relevant statutes affecting mine and quarry workers are the Coal Mines Act, 1911, and the Metalliferous Mines Regulations Acts, 1872–75, which are administered by the Ministry of Fuel and Power.

For the purpose of administering the Factories Act, 1937, the country is divided into twelve large areas termed divisions, which in turn are divided into districts. These are staffed by the inspectors of factories. In addition there are special

technical branches—medical, electrical and engineering. The medical branch (thirteen officers in all) is under the Senior Medical Inspector and the whole inspectorate is controlled by the Chief Inspector of Factories. The mines' inspectorate is similarly organised. In addition there are some 1,750 examining surgeons (formerly certifying surgeons) including appointed surgeons, with part-time duties. Each examining surgeon is appointed by the Chief Inspector for a district from amongst the practitioners practising in that district. The examining surgeons are remunerated by fees and their duties include :—

1. the certification of young persons under sixteen for fitness for employment ;
2. the periodic medical examination of persons employed in certain dangerous or unhealthy industries and of male young persons over sixteen employed at night in certain industries ;
3. the investigation of cases of industrial disease or accident ; and
4. the issuing of certificates of disablement or non-disablement from the diseases scheduled under the Workmen's Compensation Act.

Many works now employ whole- or part-time medical officers, and these medical officers may be specially appointed by the Chief Inspector to carry out the periodic medical examinations of persons in the works engaged in unhealthy processes where such examinations are required. Furthermore, by Section 126 of the Factories Act, 1937, the Secretary of State may appoint a works medical officer to examine and certify the fitness of young persons—a duty which normally falls to the examining surgeon for the district.

Under Section 66 of the Factories Act, 1937, certain diseases contracted in any factory (which is defined in Section 151 and includes a "workshop" under previous Acts and many classes of industrial undertakings which are not commonly thought of as "factories") must be notified by medical practitioners to the Chief Inspector of Factories, London, and by the occupier of the factory to the district inspector and to the examining surgeon ; and the Secretary of State may by regulations extend the list of notifiable diseases. When the Factories Act, 1937, came into force on 1st July, 1938, the notifiable diseases comprised : poisoning from lead, phosphorus, arsenic, mercury, carbon bisulphide, aniline and manganese ; chronic benzene poisoning, toxic jaundice, epitheliomatous ulceration, chrome ulceration and anthrax. Compressed air illness was added to the list as from 1st January, 1939, and toxic anæmia from 1st March, 1942. Lead poisoning

occurring in painters of buildings is notifiable in the same way under Section 3 of the Lead Paint (Protection against Poisoning) Act, 1926. "Aniline poisoning" is meant to include the effects generally known under the term "anilism," *i.e.* hæmolytic action on the red blood cells so that the lips and complexion assume an ashen grey colour, with shortness of breath, etc. Nitro-benzol and trinitro-toluol, as well as aniline, may produce these symptoms. A fee of 2*s.* 6*d.* is paid to the medical practitioner for each notification.

Under the **Workmen's Compensation Act, 1925,** an employer is liable to pay compensation to any of his employees who, through accident (or certain scheduled diseases) arising out of, or in the course of, his employment, is disabled from earning his ordinary wages, or, if death results, to the dependants of the deceased workman. Disputes as to a workman's condition, fitness for employment or whether or to what extent his incapacity is due to accident or scheduled disease may be settled by a medical referee appointed by the Secretary of State.

The following diseases have been scheduled by the Secretary of State as coming within the Workmen's Compensation Act, 1925 :—

Anthrax.
Lead poisoning or its sequelæ.
Mercury poisoning or its sequelæ.
Phosphorus poisoning or its sequelæ.
Arsenic poisoning or its sequelæ.
Poisoning by benzene and its homologues, or the sequelæ.
Poisoning by nitro- and amido-derivatives of benzene and its homologues (trinitrotoluene, aniline and others), or the sequelæ.
Poisoning by dinitrophenol or its sequelæ.
Poisoning by nitrous fumes or its sequelæ.
Poisoning by chlorinated naphthalene or its sequelæ.
Poisoning by methyl bromide or its sequelæ.
Dope poisoning (that is, poisoning by any substance used as, or in conjunction with, a solvent for acetate of cellulose) or its sequelæ.
Poisoning by tetrachlorethane or its sequelæ.
Poisoning by carbon bisulphide or its sequelæ.
Poisoning by diethylene dioxide (dioxan) or its sequelæ.
Poisoning by tri-cresyl phosphate.
Poisoning by tri-phenyl phosphate.
Poisoning by nickel carbonyl or its sequelæ.
Poisoning by Gonioma Kamassi (African boxwood) or its sequelæ.
Manganese poisoning.
Dermatitis produced by dust or liquids.

Ulceration of the skin produced by dust or liquids.

Ulceration of the mucous membrane of the nose or mouth produced by dust.

Epitheliomatous cancer or ulceration of the skin due to tar, pitch, bitumen, mineral oil or paraffin, or any compound, product or residue of any of these substances.

Ulceration of the corneal surface of the eye, due to tar, pitch, bitumen, mineral oil or paraffin, or any compound, product or residue of any of these substances.

Chrome ulceration or its sequelæ.

Scrotal epithelioma (chimney-sweep's cancer).

A localised new growth of the skin, papillomatous or keratotic, due to mineral oil.

Compressed air illness or its sequelæ.

Cataract in glassworkers.

Cataract caused by exposure to rays from molten or red-hot metal.

Ankylostomiasis.

The disease known as miner's nystagmus, whether occurring in miners or others, and whether the symptom of oscillation of the eyeballs be present or not.

Subcutaneous cellulitis of the hand (beat hand).

Subcutaneous cellulitis or acute bursitis arising at or about the knee (beat knee).

Subcutaneous cellulitis or acute bursitis over the elbow (beat elbow).

Inflammation of the synovial lining of the wrist joint and tendon sheaths.

Glanders.

Telegraphist's cramp.

Writer's cramp.

Twister's cramp caused by twisting of cotton or woollen (including worsted) yarns.

Inflammation, ulceration or malignant disease of the skin or subcutaneous tissues, or of the bones, or their sequelæ, or anæmia of aplastic type due to exposure to X-rays, radium or other radio-active substance.

Infection by *Leptospira icterohæmorrhagiæ.*

The principal diseases in respect of which compensation was paid during 1938 were (new cases): "beat knee," 4,631; dermatitis, 2,715; miner's nystagmus, 1,020; "beat hand," 1,148; "beat elbow," 745; synovitis, 571; lead poisoning, 64; epitheliomatous cancer, 65; and anthrax, 26.

Silicosis and **asbestosis.** Section 47 of the Workmen's Compensation Act, 1925, gave power to the Secretary of State to make Schemes for industries or processes involving exposure to silica dust, and the amending Workmen's Compensation (Silicosis and Asbestosis) Act, 1930, extended this power to

SILICOSIS

NUMBER OF CASES IN WHICH COMPENSATION HAS BEEN PAID

Year.	Refractories industries.		Sandstone industry.		Earthenware and china.		Metal industries.*		Mines other than ganister or sandstone.		Building industry.		Miscellaneous.		Total	
	New disablement.	Fatal.	New disablement.	Fatal.	New disablement.	Fatal.	New disablement.	Fatal.	New disablement.	Fatal.	New disablement.	Fatal.	New disablement.	Fatal.	New disablement.	Fatal.
1938	9	6	69	23	47	28	14	9	430	111	21	17	55	28	506	201
1935	8	9	75	41	69	45	17	14	217	51	28	15	38	19	452	194
1934	24	6	68	25	67	24	16	8	162	39	39	14	39	22	415	138
1933	13	6	76	29	99	31	16	13	126	28	45	17	73	30	448	154
1932	11	10	78	23	98	30	13	13	75	30	32	10	37	17	344	133
1931	11	14	82	21	91	37	15	19	43	17	13	4	28	15	283	127
1930	22	12	69	13	98	34	15	13	22	8	7	1	17	9	250	90
TOTAL	98	63	517	175	569	229	106	89	1,075	284	185	78	287	140	2,698	1,037

* The metal industries include metal grinding, sand-blasting and steel fettling.

industries and processes involving exposure to asbestos dust. Schemes under these Acts were :—

The Refractories Industries (Silicosis) Scheme, 1931, S. R. & O. 1931, No. 345.

The Sandstone Industry (Silicosis) Scheme, 1931, S. R. & O. 1931, No. 346.

The Various Industries (Silicosis) Scheme, 1931, S. R. & O. 1931, No. 342; amended to include "any operation underground in any coal mine," S. R. & O. 1934, No. 1155, and to include "any operation underground in hæmatite iron ore mines," S. R. & O. 1935, No. 69.

The Metal Grinding Industries (Silicosis) Scheme, 1931, S. R. & O. 1931, No. 343.

The Asbestos Industry (Asbestosis) Scheme, 1931, S. R. & O. 1931, No. 344.

A special Medical Board—the Silicosis and Asbestosis Medical Board, whose headquarters are at Sheffield, with other centres at Manchester, Stoke-on-Trent and Cardiff—was set up under the Silicosis and Asbestosis (Medical Arrangements) Scheme, 1931, S. R. & O. 1931, No. 341, the expenses of which are paid out of fees contributed by the employers and by workers or their dependants making claims. The fees payable are set out in the Silicosis and Asbestosis (Medical Fees) Regulations, S. R. & O. 1931, No. 412; 1933, No. 930; 1934, No. 1063; and 1943, No. 888.

Pneumoconiosis. The Workmen's Compensation Act, 1943, extends Section 47 of the Workmen's Compensation Act, 1925, to workmen suffering from any form of pneumoconiosis. Two such schemes have been made under the 1943 Act: The Coal Mining Industry (Pneumoconiosis) Compensation Scheme, S. R. & O. 1943, No. 885, and the Pneumoconiosis (Benefit) Scheme, 1943, S. R. & O. 1943, No. 886. These schemes apply to workmen employed in or about any coal mine.

Byssinosis. The Workmen's Compensation and Benefit (Byssinosis) Act, 1940, provides for compensation or disablement benefit in the case of male workmen who have died from, or become totally and permanently incapacitated for work as a result of, the respiratory disease known as byssinosis, who were employed in cotton-rooms, blowing-rooms, or card-rooms, in the spinning of raw cotton. The schemes are: The Byssinosis (Benefit) Scheme, 1941, S. R. & O. 1931, No. 525, and the Byssinosis (Workmen's Compensation) Scheme, 1941, S. R. & O. 1941, No. 526. The schemes are administered by a special Administrative Board and certificates are given by a special Medical Board. The fees payable are prescribed by the Byssinosis (Fees) Regulations, 1941, S. R. & O. 1941, No. 527.

The Factories Act, 1937, Section 46, authorises the Secretary

of State to make Special Regulations (formerly Welfare Orders) requiring provision to be made in factories for securing the **welfare** of workers in respect of the following matters : arrangements for preparing, heating, and taking meals ; the supply of drinking water ; the supply of protective clothing ; special ambulance and first-aid arrangements ; rest rooms ; the supply and use of seats in workrooms ; facilities for washing ; accommodation for clothing ; arrangements for supervision of workers. If part of the cost of such provision is contributed by the workers, the regulations may require that the workers should be associated in the management of the arrangements. Many such Welfare Regulations have been issued and elaborate welfare schemes have been introduced in some of the large factories in the country. It should be remembered, however, that large factories constitute only a small proportion of the total. *Welfare schemes* may include all or any of the following :—

1. A medical service for workpeople—including doctors, nurses, and first-aid and ambulance stations. Records should be kept of each person treated.
2. Dental clinics—in some factories all workpeople below eighteen years of age entering the service must undergo any necessary dental treatment.
3. An X-ray apparatus in large works where accidents are frequent.
4. The provision of protective clothing more particularly in connection with dusty or dirty processes, working about machinery, climbing ladders, use of acids or caustic liquids, wet processes, excessive heat, exposure to weather.
5. Messrooms and canteens. The need for these is not confined to large works. The employer may undertake the catering, or he can provide cooking facilities, crockery and cutlery, and leave the catering to the workers.
6. Welfare supervisors are usually appointed from women who have either undergone a special course of training or have served an apprenticeship under a competent supervisor. Their duties include attendance at the medical examination of young persons under sixteen years, keeping of medical records, the giving of advice as to the selection and promotion of members of the female staff, the supervision of night work and the general control of women and girls. They are in a general way responsible for the maintenance of healthy conditions in the factory, and should supervise the canteen, rest-room, first-aid section, cloakrooms and sanitary conveniences.
7. Pension and superannuation schemes.

First aid. First-aid boxes are required in all factories by Section 45 of the Act. The number of boxes and contents have

been prescribed by the *First Aid in Factories Order*, 1938. Certain of the codes of Special Regulations for dangerous trades and Welfare Regulations also prescribe special items in the boxes. Certain classes of works (*e.g.* metal works, blast furnaces, chemical works, *etc.*), *if large enough, are required to have* ambulance rooms. The Chief Inspector may exempt factories possessing ambulance rooms from the requirement for first-aid boxes.

Many useful Welfare and Safety Pamphlets have been issued by the Home Office, and an excellent illustrative display will be found in the Home Office Industrial Museum, 97, Horseferry Road, Westminster, S.W.1.

Much more has been done during the present war to safeguard the health of the worker and various Orders have been made under the Defence (General) Regulations, 1939. The first of these, the Factories (Medical and Welfare Services) Order, 1940, provided for the employment in factories of medical practitioners, nurses and supervisory officers for the medical supervision of employees, nursing and first-aid services and the supervision of welfare. At the end of December, 1942, in addition to the examining surgeons referred to on p. 145, 164 whole-time medical officers, 673 part-time medical officers, approximately 3,500 nurses, and 5,759 personnel managers or welfare supervisors held appointments in factories employing more than 250 workers.

It is now generally appreciated that diet may have an important effect upon working efficiency, absenteeism, incidence of accidents and general physical as well as mental well-being, and, with this in view, other Orders have included the Factories (Canteens) Order, 1940, which required the establishment of canteens, if directed by the Factory Department, in all factories engaged on munitions or on work for the Crown and employing more than 250 persons. As a result, by 31st December, 1942, 4,026 factories subject to the regulation had canteens in operation. Other Orders have resulted in 160 canteens being in use on the main dock estates throughout the country and 868 canteens on various special building sites in isolated parts.

Pre-war figures showed that a very large proportion of the factory population in this country was employed in works of less than 250 persons, and, although there may be an increase in post-war years in the number of large factories, no system of legislation which ignores the small factory will be complete.

So far as medical supervision is concerned, it is hoped that war-time experience of its value will bring about its proper inclusion in the future industrial organisation, efficient co-ordination of factory medical services with all other branches of medical practice, improved training of medical personnel and

the dissemination of knowledge wherever it can be applied to the benefit of the health of the factory worker. (See B.M.A. Report of Committee on Industrial Health in Factories, 1941; "The Problem of Absenteeism," Min. of Labour and Nat. Service, September, 1942; Min. of Labour and Nat. Service Conference on Industrial Health, 1943.)

The Industrial Health Research Board—under the Medical Research Council—has for a number of years been conducting a series of interesting investigations into such problems as the physiology and psychology of work, sickness absence and vocational suitability. The problem of sickness absence is intimately connected with labour wastage and an excessive turn-over of labour. Every worker who leaves after a short period of service is a serious financial loss to the employer, as it takes time for a worker to become adjusted to his surroundings and to become efficient. A recent survey of a large firm revealed the fact that out of every 100 persons engaged only sixty were still employed at the end of a year. The investigation of the amount and the causes of absence is no easy matter. In an analysis of sickness absence in 10,000 workers belonging to one firm it was found that the loss per person per annum was 4·33 days for men and 6·10 for women, 36 per cent. and 42 per cent. of this absence respectively being due to "colds" and "influenza." The next highest loss was due to "nerves" in the case of women workers and amounted to 7 per cent. In the case of men, accidents came second and "nerves" third with 5 per cent. When only long sick leave is taken into account the "nervous" type of illness accounts for the highest proportion of absence, varying very much from time to time, but lying between 10 per cent. and 30 per cent. of the total loss. Nor is this loss from "nerves" limited to women as is commonly supposed to be the case. The uneven distribution of "nervous breakdown" in different establishments seems to depend on the type of worker, the nature of the work, the contentment of the worker and other occupational factors peculiar to the individual which, so far, are not clear. "Although it has not been found possible as yet to isolate in particular cases the causative factors in sickness absenteeism, yet there is evidence to support the hypothesis that a high rate may be expected when the following occur: (1) rigidity of conditions; (2) routine work offering few prospects of promotion for intelligent workers; (3) clerical as against productive or organising work; (4) badly selected departmental heads; (5) anomalies of payment. In certain groups of clerical workers examined, security of tenure was found also to play a part in increasing the amount of absenteeism due to sickness." (M.R.C., Industrial Health Research Board Annual Reports; Special Rept. No. 75, 1936, "Sickness Absence and Labour

Wastage"; Emergency Rept. No. 2, 1942, "Lost Time, Output and Labour Wastage.")

It has been shown that the isolation and enforced absence from work of contacts of many infectious diseases are unnecessary, provided the contacts avoid the patient, remain in good health and are removed from duty on showing signs of illness during the quarantine period. (*Lancet*, 14th August, 1937, pp. 397–8; and 5th September, 1942, p. 289, Scott, W. L.)

Accidents. It has been shown by Vernon that the essential factors in accident causation are excessive speed of production as well as such environmental conditions as lighting, temperature, hours of work, and certain personal factors such as experience, age and fitness for work. The liability to accidents is largely determined by the degree of risk to which a person is exposed, but within a single working group, the members of which are exposed to equal risk, it is found that some persons are subject to what is known in technical language as accident-proneness. This "may be regarded as a set of personal qualities, some of which have been measured, rendering some people more liable than others to sustain accidents." Accident-proneness can be detected in individuals by finding out the number of accidents sustained by the individual in a working group during a previous period of exposure and by making use of special tests. Both methods should be employed. Accidents can be greatly reduced by improving environmental conditions known to be associated with them—by the fencing of machinery, by running it at the best speeds as regards safety and production, by the supervision of the young and irresponsible, and by the careful regulation and control of working hours. ("How Factory Accidents Happen," Min. of Lab. and Nat. Service, 1941; M.R.C., Industrial Health Research Board Emergency Report No. 3, 1942, "The Personal Factor in Accidents"; "An Introduction to Industrial Psychology," Smith, May, Cassell & Co. Ltd., 1943; *Lancet*, 12th June, 1943, p. 729, "Treatment of the Injured Workman," Griffiths, H. E.)

Special Regulations, which are made by the Secretary of State under Section 60 of the Factories Act, 1937, are a method of dealing with the more serious risks in particular industries. The majority of the codes are directed against risks of poisoning or industrial disease, but a few (*e.g.* the Building Regulations, the Electricity Regulations) against risk of accident. They incorporate various requirements depending on:

(1) the nature of the process and of the material used;
(2) the nature of and the mode of action of the poison or risk;
(3) the physical and chemical characteristics of the poison—
and in accordance with these criteria measures such as the following may be included.

1. Enclosure and mechanisation of the process.

2. Wet methods.
3. Application of localised exhaust ventilation.
4. General cleanliness of workrooms, use of vacuum cleaning or wet cleaning.
5. Smooth non-absorptive floors and working surfaces.
6. Avoidance of high room temperature (*e.g.* mercury) or low temperatures (*e.g.* Woodworking Regulations—against accident).
7. Prohibition of eating and of smoking in the workrooms.
8. Protective clothing—including protection of the eyes.
9. Special first-aid measures (*e.g.* ambulance rooms with resuscitation apparatus ; special waterproof plaster for covering abrasions to prevent chrome ulceration or infection by anthrax, ointment for the nose to protect the nasal septum in chrome plating.
10. Respirators, breathing apparatus and life lines.
11. Periodic medical examination
(*a*) against cumulative hazards (*e.g.* lead, carbon bisulphide),
(*b*) for the detection of precipitating factors, *e.g.* unprotected abrasions in chrome workers or precursors of more serious conditions, *e.g.* pitch warts which can be removed before epithelioma develops.

The intervals between examinations in lead process workers varies from one week to three months depending on the risk.

12. Alternation of employment, *i.e.* regular periods of work not exposed to the risk, and restriction of the length of continuous spells exposed to the risk.
13. Exclusion of women and young persons from work in certain processes.

Apart from the provisions which may be included in Special Regulations there are other preventive measures of great importance.

1. Education—particularly of the young worker (Section 21 of the Factories Act, 1937, concerning dangerous machines).
2. Prohibition of, or limitation of employment in connection with, any manufacture, process, etc., and prohibition, limitation, or control of the use of any material, or process, by the Secretary of State by virtue of Section 60.
3. General medical supervision of workers in any factory, or class of factories (Section 11).
4. Protection of the eyes (Section 49).
5. Substitution of innocuous materials for noxious material where possible (*e.g.* of non-siliceous abrasives for sand or flint in sandblasting). It will be observed that Section 5 also ensures adequate lighting.

Notifiable industrial diseases

Lead poisoning. The most dangerous lead salts used in industry are the oxide, the carbonate and the chromate. Lead

is cumulative and as little as 2 mg. a day inhaled as dust or fume is capable of setting up chronic poisoning. Industrial lead poisoning is nearly always due to inhalation of dust or

DISEASES NOTIFIED UNDER SECTION 73 OF THE FACTORY AND WORKSHOP ACT, 1901.

Disease and Industries.	Reported Cases.						
	1939.	1938.	1937.	1936.	1930.	1920.	1900.
Lead poisoning	109^{6}	96^{19}	141^{19}	163^{13}	265^{32}	289^{44}	1,058^{38}
1. Smelting of metals	8	2^{1}	11	19^{1}	37^{1}	45^{3}	34^{1}
2. Plumbing and soldering	3	4^{1}	3^{1}	3	6^{1}	3^{1}	9
3. Shipbreaking	4	13^{1}	13	11	24	3	—
4. Printing	—	4^{1}	3	3	7	9	18^{2}
5. Tinning of metals	—	—	—	—	2	2	5
6. Other contact with molten lead	5	5^{1}	14	5	19^{3}	13^{2}	30^{1}
7. White and red-lead works	10	9	4^{1}	5^{1}	3^{1}	28	377^{6}
8. Pottery	7^{3}	5^{3}	15^{9}	18^{1}	23^{10}	23^{13}	210^{8}
9. Vitreous enamelling	4^{1}	—	3	5	2	2	11
10. Electric accumulator works	4	10^{3}	10^{1}	15	36	47^{2}	33
11. Paint and colour works	13	8	13	19	6^{1}	9	56^{1}
12. Indiarubber works	—	—	—	1	3^{1}	7	1
13. Coach and car painting	1^{1}	1	6	7	10	13	70^{5}
14. Shipbuilding	5	5	1	3	5^{1}	9	32^{2}
15. Paint used in other industries	2	2^{1}	2	4^{1}	5	10^{1}	50^{5}
16. Other industries	28	6	13^{1}	18^{2}	11	18^{1}	122^{7}
17. Painting of buildings.	15^{1}	22^{7}	30^{6}	27^{7}	66^{13}	46^{21}	—
Phosphorus poisoning	—	—	—	—	—	—	3
Manganese poisoning	10	2	1	—	—	—	—
Mercurial poisoning	4^{2}	3	7	—	3	5	9
Arsenical poisoning	—	—	8	1^{1}	1	3	22^{3}
Carbon bisulphide poisoning	1	—	—	—	—	—	—
Aniline poisoning	12	9	10	7^{1}	24	—	—
Chronic benzene poisoning	2	—	1	1^{1}	—	—	—
Toxic jaundice	—	4^{1}	4^{1}	—	—	6	—
Anthrax	37^{5}	34^{5}	23^{4}	30^{1}	43^{6}	48^{11}	37^{7}
1. Wool	11^{1}	14^{1}	10	19	13^{1}	25^{7}	10^{2}
2. Horsehair	2	2^{1}	1^{1}	1	1	5^{1}	12^{3}
3. Hides and skins	19^{3}	15^{3}	7	9^{1}	24^{4}	17^{3}	9^{1}
4. Other industries.	5^{1}	3	5^{3}	1	5^{1}	1	6^{1}
Epitheliomatous ulceration.	160^{31}	165^{21}	183^{31}	142^{27}	194^{36}	45^{1}	—
1. Pitch	74^{1}	63^{2}	78^{1}	56^{1}	44^{1}	32	—
2. Tar	34^{7}	40^{6}	36^{4}	37^{11}	53^{9}	10^{1}	—
3. Paraffin	—	—	—	3	—	3	—
4. Oil	52^{23}	62^{12}	69^{26}	46^{15}	97^{26}	—	—
Chrome ulceration	159	115	101	84	95	126	—
1. Manufacture of bichromates	7	15	2	1	6	77	—
2. Dyeing and finishing	5	2	2	6	15	43	—
3. Chrome tanning	8	3	4	7	5	4	—
4. Chromium plating	91	70	53	66	57	—	—
5. Other industries.	48	25	40	4	12	2	—
Compressed air illness	12	—	—	—	—	—	—

The principal figures relate to cases and the raised figures to deaths.

fume, though at times lead may be ingested; and organic compounds may be absorbed through the skin.

In *smelting*, sulphide of lead is reduced, and the fumes given off in the process contain oxide of lead. In *plumbing* and *soldering* the use of an oxy-hydrogen blow-pipe in the welding of lead-lined tanks may produce fumes which the operator

inhales. In *ship-breaking*, when the red-lead paint is heated by an oxy-acetylene flame, fumes are generated close to the worker. *Printers*—chiefly compositors—used to suffer from the inhalation of dust, type metal being an alloy of lead and antimony. Modern methods have very largely eliminated this risk. *Red lead* (red oxide) and *white lead* (carbonate) may give rise to fumes or dust during manufacture. Here the incidence of poisoning has been reduced to a remarkable extent by the suppression of dust by wet methods and by the driving out of the water at a late stage by means of oil. In the *pottery industry* the substitution of leadless [1] and low solubility [2] glazes for raw lead (soluble) glazes has met with almost equal success (see Table, p. 155). The spraying of lead *enamels* is most dangerous unless inhalation of the spray is prevented. Stringent precautions are also required in *electric accumulator* works, particularly against the dust evolved (lead oxide) in mixing the ingredients of the paste for the plates and in pasting the plates; also against lead fume in burning the lugs on to the plates. In *painting*, the mixing of dry lead compounds and the dry rubbing down of painted surfaces are obviously dangerous; the latter process and also the spraying of interiors with lead paint are prohibited in the painting of buildings. (Lead Paint (Protection against Poisoning) Act, 1926, and the Lead Paint Regulations, 1927.) The addition of *tetraethyl lead* to petrol gave rise to some anxiety a few years ago, owing to the fatalities which occurred in the manufacture of the compound in America. No risk is attached to the ordinary use of ethyl petrol but, owing to the absorption by the skin of such organic compounds of lead, it should not be used for such purposes as domestic cleaning. Complete precautions against poisoning of the workers in the mixing of the material with petrol are taken voluntarily by the employers concerned and not a single case of lead poisoning has occurred in this country.

Symptoms of lead poisoning. Acute. Individuals may be attacked within a few weeks of commencing their work, or persons who have escaped for years may succumb. Alcoholism predisposes. Severe colic, not always relieved by pressure, may be the first symptom. Bilateral wrist-drop or foot-drop may

[1], [2] as defined in the Regulations for the Manufacture and Decoration of Pottery, S. R. & O. 1913, No. 2.

"Leadless" = not more than 1 per cent. of its dry weight of a lead compound calculated as lead monoxide.

"Low Solubility" = (1) not yielding to dilute hydrochloric acid more than 5 per cent. of its dry weight of a soluble lead compound calculated as lead monoxide when determined in the prescribed manner. (2) Containing no lead or lead compound other than galena: galena being defined as the native sulphide of lead containing not more than 5 per cent. of a soluble lead compound calculated as lead monoxide when determined in the prescribed manner as in (1).

follow, and at times even the trunk is paralysed. Acute lead encephalopathy (exceedingly rare in this country) occurs more frequently in women. A toxic hysteria may be the first sign. The woman probably falls down in convulsions while at work. Blindness, paralysis and insanity may be sequelæ.

Chronic (much more common). Anorexia, constipation, headache and a gradually increasing anæmia are the first signs. A blue line, due to the formation of sulphide of lead, may appear at the margins of the gums. Attacks of colic may occur. Peripheral neuritis, especially of the arms, and renal changes may ensue. In women abortion is frequent, and infants born alive frequently die within the first few months. Chronic poisoning seems to predispose to pulmonary tuberculosis.

Colic is the symptom which most commonly draws attention to the case, and the absence of any reference to lead as the cause may result in the treatment of the case as one of "acute abdomen." Exposure to lead may be sufficient to shorten life, causing death at an early age from chronic nephritis or cerebral hæmorrhage, although there may have been no signs of frank lead poisoning (*e.g.* colic or paralysis or paresis) during life.

In the manufacture and use of lead arsenate (used as a fungicide), the symptoms of poisoning may be those either of lead or of arsenic.

Preventive measures. An early diagnosis of lead poisoning may be made as a result of blood examination. The number of erythrocytes showing stippling (punctate basophilia (follows, after a lag of a few weeks, the degree of exposure to lead. The measurement of the response of the right extensor communis digitorum muscle to electrical stimulation (chronaximetry) is also helpful. (The *Lancet*, 25th May, 1936, pp. 206–211, Lane; *Lancet*, 11th March, 1939, pp. 559–562, Tompsett, S. L., and Anderson, A. B.) The Secretary of State has issued Special Regulations dealing with the lead risk in many processes, *e.g.* the manufacture of electric accumulators, the vitreous enamelling of metal or glass, file-cutting by hand, indiarubber manufacture, smelting of lead and manufacture of red and white lead and of certain compounds of lead, painting of buildings and of vehicles, manufacture of paints and colours, manufacture and decoration of pottery, construction and repair of ships, tinning of metal hollow-ware, etc. These Regulations contain provisions such as the following :—

1. Non-poisonous paints and processes should be substituted where possible for those which usually cause plumbism.
2. All dust, etc., should be removed by special localised exhaust ventilation, and its effects minimised by the practice of cleanliness and by damping of floors and benches.
3. Mechanical methods should replace handling of poisonous materials.

4. Workers must have every facility for washing their hands and mouths, especially before meals—2 feet of trough or one basin for every five workers, with a constant supply of warm water.

5. No meals should be taken in workrooms.

6. Respirators and overalls must be worn in the more dusty processes.

7. Medical inspection of workers at monthly (or other) intervals.

8. Exclusion of women and young persons from certain of the processes.

Other lead risks are dealt with under the general provisions of the Factories Act, especially in relation to general cleanliness and removal of refuse (Section 1), ventilation (Section 4), removal of dust and fumes (Section 47), provision of washing accommodation (Section 42).

The Women and Young Persons (Employment in Lead Processes) Act, 1920, has been incorporated in Sections 58, 59 and 109 of the Factories Act, 1937.

The Pottery Regulations, 1913, required the provision of not less than half a pint of milk or cocoa made with milk daily, at the expense of the occupier, for all women and young persons employed in certain processes and beginning work before 9 a.m. Since then the consumption of milk by workers exposed to lead in other processes has been advocated. It is considered that the calcium in the milk immobilises the lead, but the evidence of its real value is largely presumptive. (*J. Amer. Med. Assoc.*, 2nd May, 1942, p. 115.)

The various measures in operation during the present century have materially reduced the incidence of lead poisoning, as will be seen from the table on p. 155.

The number of cases notified during 1941 (59) was the lowest since notification became a statutory obligation, and the number of cases in 1942 was 72.

Phosphorus (white or yellow) is still used or manipulated in considerable quantity by a few firms in certain processes, but there was something unique about the risk in the match trade which was not abolished by stringent regulations including periodic dental supervision. This led to the White Phosphorus Matches Prohibition Act, 1908, now incorporated in Sections 51 and 61 of the Factories Act, 1937. Cases of phosphorus poisoning in this country are rare but one case, the first since 1919, was notified during 1941. The fumes gain entrance through an abrasion of the gums or a decayed tooth and cause periostitis and osteitis of the maxillary bones with destruction and overgrowth of bone, and retention of sequestra. It is a very painful and distressing disease of long duration, leaving much permanent deformity. Workers using luminous paint in the

luminising of watch dials have been known to develop rarefying osteitis of the jaw (resembling the phossy jaw of phosphorus poisoning). With a view to preventing similar trouble being involved in the painting of luminous instruments at present required on a large scale, the Factories (Luminising) (Health and Safety) Provisions Order, 1942, was issued under the Defence (General) Regulations, 1939.

Mercury. Poisoning may result from the fumes given off during roasting of the crude sulphide, or from handling the metal. Barometer and thermometer makers use the metal, and felt-hat makers and fur dressers the nitrate. In making pharmaceutical preparations of mercury, in vermilion paint works, in the manufacture of mercury arc rectifiers, in the manufacture and repair of electrical meters and in the manufacture of organic compounds of mercury there is occasional risk of poisoning. The metal volatilises readily at moderate temperatures; hence workmen employed in heated rooms run the greatest risk. Scientific instrument makers are most commonly affected nowadays. The symptoms include anæmia, tremor, a greenish-blue line on the gums, loosening of the teeth, and fœtor of the breath with salivation. The most characteristic symptoms are said to be tremor, morbid timidity and shyness. Females tend to miscarry. Fulminate of mercury is an intense skin and mucous membrane irritant.

Arsenic (*a*) Dust of salts of arsenic, arsenic oxide and the fumes of arsenic trichloride are mainly local irritants to skin and mucous membranes industrially, although, rarely, they cause symptoms of ordinary systemic poisoning. Irritation and ulceration of the skin with conjunctivitis, coryza, laryngitis occur, and also in severe cases the gastro-intestinal symptoms and peripheral neuritis commonly associated with arsenic. In addition to skin ulceration, ulceration and perforation of the nasal septum occur and prolonged exposure results in pigmentation of the skin. Arsenic is one of the industrial causes of skin cancer.

The common arsenic compounds used industrially nowadays are the oxide; the sulphide; Paris, Schweinfurt or Emerald Green (aceto-arsenite of copper) used as a fungicide; and lead arsenate also used as a fungicide.

(*b*) Arseniuretted hydrogen is a most toxic gas causing an intense hæmolysis, followed by nausea and vomiting, albuminuria, œdema, conjunctivitis, "pins and needles," and jaundice. In more severe cases the sequence is hæmaturia and strangury, severe jaundice and suppression of urine. Cases are rare and usually the result of inter-action between metal and acid, either of which contains arsenic. Other cases have been caused by the action of water on metallic residues, probably containing an arsenide.

Carbon bisulphide (CS_2) is a colourless liquid used in large quantities in the manufacture of the viscose variety of artificial silk, which is a comparatively modern invention. It has, however, been used for many years in the "cold curing" of rubber and as a solvent for rubber, oils and fats. It is not only very poisonous, but it vaporises at ordinary temperatures, and has a very low auto-ignition temperature (125°–135° C.). The vapour has a serious effect on the nervous system. Slight symptoms are produced after several hours of exposure to from 322 to 386 parts of CS_2 per million parts of air, and the inhalation of 1,150 parts is dangerous after an exposure of from thirty minutes to one hour. Chronic poisoning manifests itself by nausea, indigestion, headache, and giddiness, sometimes accompanied by attacks hysterical in character. The patient may have an anxious appearance with sweating of the hands. Still longer exposure may result in mental disturbance with impairment of memory and depression. A toxic neuritis is common, manifesting itself in weakness of the muscles of the face, forearms, and later of the lower limbs. Finally, optic neuritis may occur. In acute poisoning symptoms of severe mental disturbance, and even of acute mania, are characteristic.

The most important preventive measures are the provision of effective exhaust ventilation, alternation and limitation of employment, and periodic medical examination. All precautions against fire, including adequate means of escape, should be taken.

The Indiarubber Regulations, 1922, require that no person should be employed for more than five hours in all, in any one day, in a room where carbon bisulphide is used, nor for more than two and a half hours at a time without a rest interval of at least one hour from any employment. (Home Office Memo., Form 836, November, 1935.)

Aniline poisoning. Poisoning by nitro and amido derivatives of benzene and its homologues.

The term "aniline poisoning" includes the effects generally known under the term "anilism," *i.e.* cyanosis, anæmia and shortness of breath, resulting from poisoning not only by aniline, but by other nitro and amido derivatives of benzene and toluene, *e.g.* dinitrobenzene, dinitrotoluene, trinitrotoluene, paranitraniline, etc. We may expect to find these effects in workers engaged in the manufacture of explosives and in the making of dye-stuffs. Dinitrobenzene and trinitrotoluene are common explosives. Also nitrobenzene is a solvent for some dyes and is used to perfume soaps and polishes. Shoe polishes and dyes may also contain aniline. All these substances act on the blood with the formation of methæmoglobin and consequent hæmolysis.

The symptoms following absorption depend, of course, on the amount of blood destruction and consequent overloading of the liver, but the cardinal ones are cyanosis, anæmia and shortness of breath. A grey-blue colour is first noted in the mucous membranes, lips and ears and may be remarked upon by others before the affected persons feel ill. The reduction in the oxygen-carrying power of the blood is responsible for a variety of symptoms and cases may progress to a fatal issue with convulsions or delirium, increasing lividity, coma and death. Peripheral neuritis and jaundice may develop.

The most important channel of absorption is the skin. The liquid derivatives, as aniline and mononitrobenzene, are absorbed through the skin with great rapidity and cases are on record of deaths from splashes with these liquids and from walking through quantities which have been spilt. Dinitrobenzene is more toxic than either dinitrotoluene or trinitrotoluene, but the last named obtained an unenviable reputation as a cause of toxic jaundice and (rarely) of aplastic anæmia during the exceptional circumstances of the war of 1914–1918. In the cases of toxic jaundice the poison exerted a specific effect on the liver, the pathological picture being that of an acute yellow atrophy with subsequent cirrhosis.

Trinitrotoluene also causes dermatitis with erythema and vesiculation with a "sago-grain" or cheiropompholyx appearance on the hands : there may be intense irritation with complete exfoliation of the skin. A peculiar feature of a number of the amido compounds is the production of tumours of the bladder, both benign and malignant.

The main preventive measures are periodic medical examination, localised exhaust ventilation for dust or fumes, enclosure and mechanical methods, protective close-fitting clothing, head covering and gloves, general cleanliness, no dry sweeping, adequate washing and bathing accommodation, the rotation of personnel, exclusion of young and unhealthy persons and alcoholics, extra supplies of milk. When a person is splashed with aniline or nitro-benzene, clothes should be removed and the material washed off immediately with some solvent, preferably acetone.

Chronic benzene poisoning. Benzene is a coal tar derivative and includes benzol. Nowadays very large quantities are obtained by stripping coke-oven gas, and it is used as a motor fuel, as a solvent or diluent, in "dry" cleaning, in the chemical industries, and in the manufacture of explosives. Chronic poisoning may result from the inhalation of the vapour over a period of time varying from about a week to months, or even years. The late Sir Thomas Legge stated it as his opinion that the atmosphere in cases where chronic poisoning had occurred

contained probably more than 20 parts per 10,000 of air. Henderson and Haggard state "No definite figures have been established for the concentrations of benzene causing chronic poisoning. Analyses of the air in factories where poisoning has occurred give values ranging from 5,000 down to 200 parts of benzene per million parts of air."

It is important to ascertain whether benzene is used or is present in any solvent or mixture of solvents, rubber cement, cellulose lacquer, etc., which is used in such a way as to give off fumes into the air of the workroom. There are many common volatile coal tar and petroleum distillates such as solvent naphtha, petroleum naphtha, white spirit, benzine, ligroin, petrol, lythene, benzoline, etc., used in industry, but for practical purposes under industrial conditions only benzene and mixtures in this group containing benzene produce chronic poisoning with a serious prognosis.

Benzine is a very confusing term : it is usually applied to a petroleum distillate which, in general with other petroleum distillates, contains little or no benzene, but some commercial benzines may contain as much as 40 per cent. of benzene ; moreover, the terms benzine and benzene themselves have often been confused in reports of cases of poisoning attributed thereto.

The benzene content of the industrial solvents in these classes is therefore of first importance from the toxicological point of view, for the risk of serious chronic poisoning from inhalation varies, other things being equal, directly with this content. All these distillates, including benzene, have dangerous acute narcotic effects if inhaled in sufficient concentration and acute gassing accidents in factories by these substances, including benzene, are notified as such to the inspector for the district. Continued exposure to the fumes of any of this group of solvents will result in depression of the general health and in the exhibition of symptoms in great variety, of which headache, giddiness, nausea and mild digestive disturbances, and somnolence or insomnia, are the most common. Recovery is, however, rapid with cessation of exposure and ordinary symptomatic treatment, unless benzene is the cause, in which case there are dangerous possibilities. Benzene destroys the bone marrow and therefore causes severe anæmia. While slight anæmia may accompany and form part of the depression in general health which is associated with long exposure to various members of this group, benzene, under industrial conditions, is unique amongst them in this respect both in its rapidity of action in many cases and in the intensity of the effect produced. Clinically the picture of chronic benzene poisoning is that of a progressive anæmia with purpura and hæmorrhages from mucous membranes. Although it

may occur only after many years' exposure, many fatalities have occurred after only a few weeks' exposure.

Benzene is primarily a toxin for the granular leucoblastic and for the thromboblastic tissues. The total leucocyte count may fall in chronic benzene poisoning to a very low level; in fact, the white cells may almost disappear. A count of 1,000 to 2,000 is common. The red count may be extremely low, about three-quarters of a million, or only a moderate anæmia with a count of three million and upwards may be present.

In diagnosis the importance of any history of exposure to benzene is self-evident; this, together with leucopenia and a relative lymphocytosis with or without reduction in the red count, should ensure the removal of the patient from exposure and his treatment. The prognosis in chronic benzene poisoning is obviously very serious and depends on the degree of permanent damage to the bone marrow; when marked signs are present irreparable damage is likely to have occurred.

Since benzene is outstanding in this group in its chronic toxic effects, its substitution wherever possible by other solvents without such dangerous potentialities is the method of first choice. At the same time methods for complete protection against accidental acute gassing and for the prevention of the escape of fumes of any of these solvents into the workroom are necessary. Where benzene is used, periodic medical examination, including examination of the blood, is of value, but of much more importance is the prevention of escape of fumes into the workrooms and day-to-day supervision of the ventilating apparatus.

Toxic jaundice. The most important causes of toxic jaundice under industrial conditions are tetrachlorethane, arseniuretted hydrogen and trinitrotoluene; but other nitro and amido derivatives of benzene and its homologues, and also carbon tetrachloride, should be remembered in this connection.

The severe jaundice associated with poisoning by arseniuretted hydrogen is due to the intense hæmolysis produced; and mild jaundice due to blood destruction is a concomitant in some cases of poisoning by nitro and amido derivatives of benzene and its homologues.

Tetrachlorethane, however, has only a slight effect on the blood picture (although of importance in early diagnosis), but, in common with trinitrotoluene (and more rarely other related compounds), it attacks the liver directly, causing a picture of acute yellow atrophy.

Because of this risk, which affects a fair proportion of those exposed even where the substance is present only in low percentage, tetrachlorethane is one of the most dangerous solvents and therefore its use has much diminished. Moreover, tetrachlorethane has an attractive odour which adds to the risk.

The toxic effects of carbon tetrachloride on the liver and the kidneys have been much studied in relation to the use of this drug in the treatment of ankylostomiasis. Ingestion of carbon tetrachloride has a profound effect in this direction, but what is perhaps less generally appreciated is that inhalation of the fumes may exert the same action and seriously damage these organs with or without the production of jaundice. There is some evidence, however, that the liver cells may be regenerated on cessation of exposure, if not too long delayed, and complete recovery may take place without the development of cirrhosis.

Chlorinated naphthalenes in the form of waxes are used for insulating purposes and cases of toxic jaundice have occurred from the inhalation of the fumes. (*B.M.J.*, 6th June, 1942, p. 691, McLetchie, N. G. B. and Robertson, D.)

Industrial solvents generally. Knowledge concerning the toxicity of many of this large and expanding group of substances is lacking or fragmentary, but the data already available in respect of some of them are most valuable. Some solvents are dangerous only because of acute effects, others because of delayed or chronic effects, while others exhibit either acute or chronic effects depending on the conditions of exposure.

When the choice of a solvent for an industrial purpose is under discussion these aspects of the problem are of importance and worthy of much more consideration than they usually obtain. While the occurrence of a single acute and possibly fatal case of poisoning is in itself a patent warning, the insidious and delayed but equally serious action of some solvents may be unrecognised until mass effects are produced. The problem is not always an easy one because consideration has to be given, not merely to the qualities which may make a solvent suitable for a particular industrial purpose, but also to its toxicity and the possible risk of fire. Not infrequently, however, substitution of a solvent with less toxic potentialities is not of serious moment from the technical point of view and on balance ultimately turns out to be a distinct advantage. The benefits from the lessened risk to health are evident. Examples of the more commonly used solvents which should be replaced wherever possible by less risky substitutes are tetrachlorethane, benzene and carbon bisulphide, all because of the serious and insidious results of exposure to comparatively low concentrations. Carbon tetrachloride follows not very far behind.

Sufficient has been said to emphasise the importance of the exercise of great care in the choice of any chemical substance so as to avoid risk to workers or the public. A dangerous substance may often be used in a manufacturing process in a factory with perfect safety provided appropriate precautionary measures are fully carried out; whereas the use of the same

substance by the ignorant and unskilled without precautions will inevitably bring disaster. In particular, it should not be assumed that, because there is no evidence that a substance is not toxic, the substance is in fact not toxic in any circumstances. Absence of data as to toxicity is, of course, no proof of innocuousness. Moreover, certain poisons are cumulative and also have a definite threshold value at which frank poisoning becomes evident. Again, use under abnormal conditions may intensify exposure and cause poisoning which would not normally occur.

Illustrations of some of these points are reported cases of poisoning among users of polishes and shoe-dyes containing aniline or nitrobenzol (absorption through the skin); recent cases of poisoning by diethylene glycol used as a solvent for sulphanilamide (ingestion); poisoning from ortho-tricresyl phosphate used as a substitute for ginger essence (ingestion); poisoning by dioxan (di-ethylene dioxide), one of the newer solvents with a cumulative action on the liver and kidneys (inhalation and absorption by the skin).

Carbon tetrachloride as well as certain other chlorinated hydrocarbons, of which trichlorethylene is the most important, are decomposed by passage through a flame with the formation of a proportion of phosgene. This effect has been shown to occur with passage of the vapour through a lighted cigarette, and its importance lies in the risk of phosgene poisoning to those in the neighbourhood when the liquid is projected, or the heavy vapour falls, on to a flame. Thus cases of poisoning have occurred as a result of fires being extinguished in confined places with fire extinguishers containing carbon tetrachloride.

Trichlorethylene. Very large quantities of this substance are used each year in this country, mostly for degreasing of metals and for dry cleaning. It is not inflammable, but as mentioned previously can be decomposed by a flame with the production of phosgene. Apart from this possibility, the danger of trichlorethylene lies in the acute narcotic effects of the vapour, which in concentration acts very rapidly. Many cases of serious gassing and some deaths have occurred among persons entering degreasing tanks to clean out the sludge. No evidence has been obtained in this country of any chronic effects or cumulative action of this solvent.

Anthrax (see p. 129).

Epitheliomatous ulceration of the skin may occur among workers in any process where tar, pitch, bitumen, mineral oil or paraffin is used. Mule-spinners in cotton works tend to suffer from a cancer of the scrotum due to exposure to finely divided particles of lubricating oil. Between 1920 and 1934 there were 785 cases of industrial skin cancer with 122 deaths

among persons working with patent fuel, in tar distilleries, in gas works, and in other processes connected with pitch or tar; 36 cases with 3 deaths among shale oil refiners; and 940 cases and 298 deaths among mule-spinners and others coming in contact with mineral oil. Preventive measures include avoidance of contact (so far as is practicable) with carcinogenic substances, the use of protective clothing and special ointments, and periodic medical inspection. The value of such inspection lies in the detection of tar and pitch warts at a stage when treatment is easy and effective.

Chrome ulceration occurs mainly among workers engaged in chrome plating and anodic oxidation, although those manufacturing or working with bichromates may also be affected. Chrome plating and anodic oxidation are electrolytic processes which are done in a bath containing chromic acid. The gas given off carries with it very fine particles of liquid from the baths which affect the nasal septum, causing ulceration and perforation. Chrome ulcers or holes are the result of chrome getting into cracks or cuts in the skin. The Chromium Plating Regulations, 1931, require the provision of localised exhaust ventilation over the bath, and of aprons, rubber gloves and rubber footwear. Adequate washing facilities and an ointment containing vaseline and lanoline (for the hands and nose) and special impermeable waterproof plaster must be available. Workers have to be examined every fourteen days by the surgeon, and the hands and forearms of workers twice a week by a responsible person. The object of these examinations is to detect chrome ulceration of the skin and nose and chrome dermatitis, and also to make sure that cuts and abrasions are properly dressed and covered with the impermeable waterproof plaster so as to prevent the chromic acid entering. Chrome ulceration will extend and refuse to heal so long as any chromic acid remains in the wound. No person under eighteen years of age may be employed at any vessel used for an electrolytic chromium process or for any process subsequent thereto. Chrome ulceration of the nose never attacks the bone, but only the cartilaginous septum. There is therefore no deformity and workers may be unaware that a perforation has occurred. The official cautionary placard relating to the effects of chrome on the skin must be affixed in the workroom.

Chloracne. Among workers in chlorinated naphthalenes and chlorinated cutting oils an acneform skin eruption ("chloracne"), characterised by pustules, papules and comedones is common. The comedones are often accompanied by pruritus, and paronychia of the fingers sometimes occurs. The eruption is characteristically present on the extensor surfaces of the arms, especially around the elbows. Workers should be

provided with clean work clothes daily and with sleeves and aprons made of a material impervious to oil. They should also be provided with a protective ointment of the type which forms a water-soluble, oil-repellent film for use on the face and neck, and shower baths after work should be made compulsory. (U.S.P.H.S. Report No. 47, 20th November, 1942, pp. 1747–52.)

Other metallic poisons

Metal fume fever. This is a group of allied conditions of which originally only one form was known, that termed "Brassfounders' ague." It was found that the condition was very common amongst casters of yellow brass containing about 30 to 40 per cent. of zinc and 60 to 70 per cent. of copper, whereas it was comparatively unknown in casters of bronze containing only 5 per cent. of zinc. The addition of the zinc (boiling point 930° C.) to the molten copper (melting point 1,083° C.) produces dense clouds of hot zinc oxide which are inhaled. The symptoms come on some hours later and are very suggestive of a malarial attack with shivers, headache, fever and sweating. Some very temporary acclimatisation to the fumes is acquired. Of latter years similar effects have been found in welders of manganese bronze, oxyacetylene cutters of galvanised metal (in ship breaking) and workers in copper rolling mills. Recovery from an attack is remarkably quick.

Cadmium. The fumes of cadmium, *e.g.* in melting cadmium or cadmium alloy, or from the use of cadmium electrodes, have serious and even fatal effects with influenza-like symptoms, dyspnœa, sickness and irritation of the throat. Similarly, cadmium oxide dust produces gastro-intestinal disturbances with diarrhœa.

Manganese. Serious cases of chronic poisoning by manganese dioxide have occurred from exposure to the dust of that substance in unloading, grinding, sieving, etc., of manganese ores and the handling of manganese dioxide in various processes. The clinical picture is very similar to chronic post-encephalitic-Parkinsonism with emotional disturbances, monotonous voice, mask-like face and spastic gait. Significant pathological changes are found in the basal ganglia. General health does not appear to be impaired, but those affected become life-long cripples.

Other poisonous gases

Carbon dioxide is a simple asphyxiant and also, as used therapeutically, a profound stimulant to the respiratory centre. With increase in the carbon dioxide content of the air, therefore, there is increase in the rate and depth of respiration. Obviously, however, there is a limit beyond which a respiratory exchange

cannot be maintained. For these reasons a carbon dioxide content of 10 per cent. is only respirable for a very brief period. Apart from the carbon dioxide content in the air any diminution of the oxygen content below 12 per cent. produces symptoms due to deprivation of oxygen. Sometimes in industrial processes these factors operate conjointly to produce symptoms. Many of the industrial processes concerned are in connection with fermenting vats of breweries, with excavations, wells, cleaning of tanks, work in ship holds particularly where grain has fermented, and in the proximity of lime kilns (carbon dioxide and carbon monoxide).

Carbon monoxide is found in blast-furnace gases, manufacture (and escapes) of ordinary illuminating gas (15 per cent. CO), mine explosions, coke ovens, motor-car exhausts, etc. During 1939 there were 84 cases of poisoning reported to the Home Office with 5 deaths. The gas is odourless. A loose combination of CO with hæmoglobin is formed, with the result that oxygen cannot be carried to the tissues. The affinity of CO for hæmoglobin is approximately 300 times that of oxygen. With about 0·08 per cent. of CO in the air the hæmoglobin becomes half saturated, and with 0·16 per cent. two-thirds saturated—thus doubling the amount of CO in the air does not necessarily double the degree of saturation in the blood; 0·1 per cent. causes symptoms of headache and lethargy within one hour, while 0·3 per cent. may produce unconsciousness in twenty minutes, 0·5–1 per cent. is rapidly fatal. The permissible concentration for several hours' exposure is 0·01 per cent. The symptoms are vomiting, giddiness, headache, ringing in the ears and great lethargy. Convulsions and coma may supervene, but loss of motor power usually occurs before unconsciousness. If active exercise is indulged in the rate of saturation increases and poisoning results more rapidly. Carbon monoxide, in company with some other gases, notably sulphuretted hydrogen, hydrocyanic acid, phosphoretted hydrogen, acts with startling rapidity if in sufficient concentration. The affected person has no warning and falls down as if struck by a blow, and death follows in a few moments. With carbon monoxide this feature is the cause of many serious accidents since the gas is odourless and there is thus no appreciation of its presence. Carbon monoxide is by far the most common cause of gassing in industry. *Post mortem:* the pupils are dilated, the blood is bright red and small hæmorrhages into many of the body tissues may be found. Artificial respiration and the administration of oxygen with 7 per cent. CO_2 are the best remedial measures once the patient has been removed from the poisonous atmosphere. (U.S.P.H.S. Report No. 10, 7th March, 1941, "Carbon Monoxide: its Toxicity and Potential Dangers.")

Sulphuretted hydrogen is given off in many processes and incidental conditions obtaining in industry—in the chemical industry; where sulphides are used as in tanning; wherever waste organic materials are collected and decomposition occurs, *e.g.* the storage of green hides, in breweries, sugar factories; and especially is it encountered in the cleaning of tar stills. The gas should also be apprehended in sewers and excavations. Small amounts are liberated in the spinning of artificial silk by the viscose process but sufficient to cause acute conjunctivitis in

CASES OF POISONING BY FUMES AND GASES OCCURRING IN FACTORIES AND WORKSHOPS REPORTED AS ACCIDENTS INVOLVING AT LEAST THREE DAYS' ABSENCE FROM WORK.

	1936.	1937.	1938.	1939.
Carbon dioxide	—	4^{2}	1	2^{1}
Carbon monoxide:				
(*a*) Blast furnace gas	26^{5}	37^{7}	37^{9}	27^{4}
(*b*) Power gas	19^{1}	24^{2}	21^{1}	24^{1}
(*c*) Coal gas	14^{1}	17^{4}	19^{2}	18
(*d*) Other	27^{1}	14	21^{2}	15
Hydrocyanic acid	—	2	1	—
Ammonia	3	8^{1}	4	1
Hydrochloric acid	1	1	1	—
Chlorine	7	19	17	29
Sulphur dioxide	1	12	4	2
Sulphuretted hydrogen	5	3^{1}	10^{7}	6^{2}
Nitrous fumes	6	7^{1}	14^{1}	9
Phosgene	2	4	1	—
Naphtha, petrol & benzine	3	2	3	3
Trichlorethylene	8^{1}	7	3	9^{2}
Benzol	3^{1}	4^{2}	1	1
Nickel carbonyl	8	7	8	10
Other	20^{2}	24	24^{5}	28^{2}
Total	153^{12}	196^{20}	190^{27}	184^{11}

The principal numbers relate to cases; the raised figures to deaths.

the absence of very efficient localised exhaust ventilation. As small an amount as 0·1 to 0·3 per cent. may prove rapidly fatal.

Nitrous fumes form the well-known reddish-yellow or reddish-brown fumes which are given off from fuming nitric acid, and when the acid acts on organic substances or metal. These fumes are exceedingly dangerous, since they can be breathed with only slight inconvenience in concentrations which will cause œdema of the lungs after only a short exposure. The effects of the gas are similar to those of phosgene. There is the same very slight initial irritation followed by a period of well-being and later by the development of pulmonary œdema.

This sequence of events is so characteristic that diagnosis can be made on the history alone. The majority of industrial cases of poisoning occur in the manufacture of nitric and sulphuric acids, in the dipping of brass and copper articles in nitric acid, from the breaking or upsetting of carboys of nitric acid, and in the manufacture of explosives and other nitro-compounds. Mass poisoning has been caused by the burning of celluloid stores (*e.g.* radiographic films in Cleveland, U.S.A. in 1929) or stores of other nitrated bodies, *e.g.* cordite, in which circumstances great volumes of nitrous fumes are liberated. Nitrous fumes are often evolved also in obscure circumstances, as when electric welding is carried out in a confined space. As with phosgene poisoning, great care should be taken to keep these cases at complete rest and not to be deceived by the period of well-being which precedes the appearance of signs of pulmonary œdema. Early and continuous administration of oxygen, as for phosgene poisoning, is necessary. If nitrous fumes can be seen at all, there is serious danger unless there is no chance of their escape into the air breathed. All workers, except those properly protected, should be removed from the dangerous area immediately. Spilt nitric acid should be hosed away with large quantities of water by men protected by efficient breathing apparatus.

Methods for the detection and estimation of twenty-one of the toxic gases and vapours most commonly encountered in industry have recently been standardised. (Leaflets Nos. 1 to 12, Dept. Scientific and Industrial Research, reviewed in *Bull. of Hyg.*, February, 1941, pp. 53–59.)

Other skin diseases

Dermatitis is common in certain industries, its causative agents being alkalies, oil, sugar, friction and heat, turpentine and substitutes, various chemicals, chrome, petrol, paraffin, dough, French polish, etc. Baker's dermatitis has been thought by various workers to be due to protein sensitivity, to the presence of a mycelium in the flour or to the use of ammonium persulphate as an "improver." During 1939, 2,952 cases of dermatitis were reported to the Home Office as due to industrial conditions. The greatest number of cases of dermatitis occurred among workers in chemical manufacture and the next highest incidence was among mechanical engineers—due to contact with lubricating oil—and among workers employed in the manufacture and making up of textiles. The increased incidence of dermatitis is due to the increasing number of entrants into industry and of materials used which may give rise to this condition. In the great majority of cases the effect on the skin caused by the irritant quickly subsides on removal from contact with it, and, with appropriate treatment and

protection of the affected part, continuance at even the same type of work may not be impracticable. There are few things in industry which, if used repeatedly, will not cause dermatitis in some people but, with proper care of the skin and effective cleanliness, few should be affected. Whatever protective methods may be used, adequate washing facilities and supervision of washing are essential factors in the prevention of dermatitis and success depends on the co-operation of the individual worker. Injury to the skin in the first instance is probably an important factor, and a periodic inspection of all workers in processes where dermatitis is likely to occur is an essential measure. Sometimes the use of an emollient ointment is of service when the skin is exposed to a defatting agent, such as spirit or turpentine; and Dakin's solution has been found helpful in certain engineering works. These preparations should be used if possible before and after work. (*B.M.J.*, 19th August, 1933, pp. 324–327, Bridge.)

Inflammatory conditions of the skin followed by subcutaneous cellulitis occur among miners and are largely the result of working in a cramped position in certain parts of the mine. They may occur in the hand, "beat hand," in the elbow, "beat elbow," or in the knee, "beat knee." In the hand the repeated traumata caused by the handle of a pick leads to a localised inflammatory condition of the palm which spreads to the deeper tissue leading to cellulitis and may lead to a definite impairment. Both "beat knee" and "beat elbow" are inflammatory conditions of the skin over an acute bursitis.

Diseases due to dust

Industrial dusts may be classified as follows :—

(1) Dusts which are systemic poisons, such as lead, arsenic, manganese, trinitrotoluene and many others.

(2) Irritant or corrosive dusts, such as lime, arsenic, chromic acid, the bichromates and many others in varying degrees.

(3) Allergic dusts, exposure to which may result in the development of a hypersensitive state and cause on further minimal exposure asthma, rhinitis, urticaria, etc. Usually these conditions are due to foreign proteins in the dust, but not always, as, for example, in the case of workers with chromic acid and the bichromates who may become hypersensitive to these chemicals.

(4) Carcinogenic dusts, such as the dust of pitch, of radioactive materials and of certain ores.

(5) Dusts which carry infections such as anthrax, monilia and actinomyces.

(6) Non-toxic inorganic dusts which have a deleterious effect on lung tissue, producing such diseases as silicosis.

Workers in flax, hemp, cotton, feathers, grain hay, straw

and certain hard woods are liable to suffer from irritation due to the inhalation of dust. Cotton workers suffer most in opening the bales and in the carding process. "Cardroom workers' asthma" causes a good deal of incapacity; it is most noticeable in the beginning of the week, as operatives appear to be more sensitive to it after the week-end. "Weavers' cough" occurs at times in epidemic form in a weaving-shed. (M.R.C. Report, No. 212, 1936.)

Bagassosis. Bagasse is broken sugar-cane after the sugar has been extracted. It is used in the manufacture of board and has insulating properties against sound and temperature. It is largely composed of fibre and the dust is capable of initiating a pathological process in the lungs. Although bagasse contains silica, the illness produced is unlike any known form of silicosis and it is possible that whole bagasse contains an antigen to which workers who inhale the dust become sensitised. (*B.M.J.*, 24th October, 1942, pp. 478–80, Castleden, L. I. M., and Hamilton-Paterson, J. L.; and 14th November, 1942, pp. 577–78, Gillison, J. A., and Taylor, F.)

Inorganic dust. The pneumoconioses are diseases of the lungs due to the inhalation of dust and are characterised by fibrosis in the lung substance. The most important dust in this respect is silica and the disease produced is known as silicosis. Tuberculosis is a common complication. The silica inhaled is in the form of free SiO_2 as quartz, flint, etc. To produce the disease the particles must be inhaled into the alveoli and must be from 0·5 to 5μ in diameter—the average size of the particles in a silicotic lung being about 1μ. It is thought that the silica enters into solution and some form of biochemical action takes place which results in the production of fibrosis.

Silicosis, which continues to be serious and widespread, is prevalent wherever people work with silica-containing material. The first symptom is usually dyspnœa, and this may continue for years. Diagnosis is greatly assisted by radiological examination. The course of the disease is usually slow. In chronic cases death generally results from broncho-pneumonia, frequently following influenza. Attempts are being made to determine the concentration of dust that may be considered safe in the various industries concerned, the chief of which are:

1. Refractories industries—concerned with the manufacture of ganister and silica bricks used for the lining of high-temperature furnaces. These bricks contain a high percentage of silica, often over 90 per cent.

2. Sandstone industry—quarrying and dressing the stone. Stonemason's phthisis is well known in certain districts. Mechanical work is taking the place of hand work, and devices are available for removing dust from the pneumatic tools used in dressing the stone. Granite workers are also subject to silicosis.

3. Metal grinding—"Grinder's rot" has been common in the manufacture of cutlery and edged tools, which are ground on wheels of sandstone. The sandstone wheel is being replaced by abrasive material, such as carborundum, which appears less harmful; and local exhaust ventilation and the use of wet processes have helped to lower the incidence.

4. Sand-blasting consists in playing a jet of sand under high pressure against metal or glass surfaces to produce certain effects. The operator may be protected by a helmet and breathing apparatus, or he may work by passing only his hands into the cabinet where the blasting is being done. The use of shot instead of sand in sand-blasting clean articles has greatly reduced the dust hazard in this industry.

5. Pottery manufacture. "Potter's asthma" is the old name for silicosis in this trade. The silica is encountered in earthenware and in the ground flint in which china is packed for firing. Pottery workers provide a large number of cases of silicosis in this country, but the introduction of alumina instead of flint as a placing medium for china has done much to reduce the incidence among this group.

6. Ground silica is used largely for domestic scouring powders, in the manufacture of certain vitreous enamels, for insulating materials, etc. Those engaged in any stage of the crushing, grinding or handling of the silica are subject to risk.

7. Tin-miners in Cornwall have suffered in the past as the tin ore is found in a highly siliceous rock.

8. Coalminers, especially those in the anthracite mines of South Wales, show a high incidence, due not to the coal dust, but to the siliceous dust raised in cutting through stone to reach the coal seams. The primary dust effect in such cases is not a simple anthracosis, but a mixed pneumoconiosis in which silica is always present, though its effect may be latent.

9. Asbestosis occurs as a result of inhalation of asbestos dust over a period of several years. Asbestos is a silicate, and owing to its fibrous character the free particles are usually very thin, elongated fibres. The disease resembles silicosis, though there are definite pathological differences, and tuberculosis does not supervene so frequently. The most dangerous processes are the crushing and opening of the crude asbestos, blowing and carding the fibre, spinning yarn and weaving asbestos textile material, and the making of slabs, etc.

The total number of cases in which compensation was paid under the various Silicosis and Asbestosis Special Schemes (see p. 147) in 1938 was 2,739 and the total amount of compensation paid was £230,962. These cases included 645 new cases and 222 deaths from silicosis or asbestosis or either of these diseases accompanied by tuberculosis. There were 9 new cases and 6 deaths from the refractories industries; 69 new cases and

23 deaths from the sandstone industry; 47 new cases and 28 deaths from the china and earthenware industry; 14 new cases and 9 deaths from metal industries; 430 new cases and 111 deaths from the coal mining industry; 21 new cases and 17 deaths from among builders, etc., and 55 new cases and 28 deaths from other industries.

For estimating the dust hazard in industry the most accurate results are obtained by using the thermal precipitator. In this method samples of air are taken over a period of several minutes at face level of the operatives in the industry concerned. The dust from a measured quantity of air is deposited on cover-slips on which it can be counted and the size of its particles measured. It is also possible to say whether the particles are composed of siliceous or other material. (M.R.C. Special Report No. 199, 1935.)

The most important preventive measures in all these dusty trades are:—

1. Suppression of dust, especially by the use of water.
2. Localised exhaust ventilation applied as near as possible to the point of origin of the dust, and so arranged as to prevent the dust from entering the atmosphere of the workroom. Special care must be taken in the collection of the dust, as the particles are so small that they are not readily trapped. Dust traps should be attached to percussion drills worked by compressed air in mines and quarries.
3. Special helmets and respirators are available, but, though the former are useful in sand-blasting, these articles can never be a substitute for proper exhaust ventilation. Regulations to protect workpeople are now in force in a considerable number of industries.
4. Initial and periodic medical examinations are of great value.

(Memo. on Silicosis and Asbestosis, Home Office, 1935.)

Illness due to alteration in atmospheric pressure

Compressed air illness or caisson disease may be found in workmen employed in an atmosphere of compressed air, *e.g.* in building the foundations of a bridge in the bed of a river. Before the workmen enter the caisson where work is done they pass through the "air-lock," where they are subjected to a pressure which is raised gradually till it equals that in the caisson itself. Before leaving they are slowly decompressed. For every 33 feet of depth in water a pressure of one atmosphere is required to keep water out of the caisson—*i.e.* at 100 feet depth a pressure of three atmospheres, or 45 lb. per square inch, must be maintained. The maximum working depth at present is about 182 feet. Unpleasant symptoms may arise during compression. Among these is "blocked ear,"

which is some disturbance to the tympanic membrane, tympanic cavity or both, resulting from failure to equalise the intra- and extra-tympanic pressures. It occurs while the worker is being compressed in the air-lock. The immediate symptoms are a severe stabbing pain and a sensation of extreme fullness in the affected ear. It is, however, during or after decompression that the real symptoms of compressed air illness occur. As a rule, within from a few minutes to several hours after leaving the "air-lock" the man complains of severe pains known as "bends" in the muscles and joints. These may last for many hours. Paralysis of the legs, retention of urine, abdominal pain, vomiting, vertigo and bleeding at the nose may be noted. It is, however, only in the severe forms that the spinal cord is affected. The symptoms are probably due to too rapid decompression whereby the gas that has been forced into the blood under pressure tends to reappear as minute bubbles in the vessels and tissues, with consequent loss of function of the areas supplied.

Preventive measures are :—

1. Selection of the workmen, excluding all with catarrhs, weak lungs or heart disease. The best age is between twenty and thirty. Alcoholism predisposes.

2. Slow decompression and short working shifts corresponding with the degree of pressure employed. Hill and MacLeod recommended that for a pressure of 30 lb. there should be a four hours' working shift and a decompression period of thirty to sixty minutes, and so on, at greater depths lessening the working period and increasing the decompression period. One minute of decompression should be allowed for every 3 lb. of pressure.

3. Pure air, cooled if possible, should be supplied to the caisson. Treatment consists of recompression as soon as symptoms appear, followed by very slow decompression at the rate of three minutes per pound. For this purpose it is advisable to have a medical "air-lock" specially warmed as decompression is accompanied by a fall in temperature.

NOTES ON VARIOUS ANIMAL PARASITES

PARASITIC WORMS

The worms found parasitic in man or met with during food inspection belong to two quite distinct groups, or Phyla, of the

invertebrates, viz., Nemathelmia (or round-worms) and Platyhelmia (or flat-worms). There are many free living forms in each of these two groups, *e.g.* the "horsehair" worms which occasionally appear in reservoirs and even in tap water, and planarians which are common in ponds and under stones in running streams.

Nemathelmia

The round-worms are cylindrical with a body space full of fluid in which the genital tubes float freely. The sexes are always separate. They give rise to "simple" eggs, the shell containing only an ovum. The flat-worms are leaf-like, pear-shaped or tape-like in form and give rise to "composite" eggs, *i.e.* within the shell there are numerous yolk cells in addition to the ovum. They are hermaphrodite, except the Bilharzia worms in which the sexes are separate.

The round-worms are easily differentiated by an examination of the œsophagus which is either (1) a double-bulbed organ; the club-shaped anterior part is succeeded by a round bulb joined by a narrow neck; this occurs in *Oxyuris* (*Enterobius*), or (2) a club-shaped organ with muscle fibres radiating from the lumen to the circumference; this is the commonest type and occurs in *Filaria*, *Dracunculus*, *Ascaris* and *Hook-worm*. These four genera may now be distinguished by an examination of the mouth which is either (*a*) a simple pore: *Filaria*, including *Dracunculus* (guinea-worm), or (*b*) is guarded by three lips: *Ascaris*, or (*c*) opens into a buccal capsule: Hook-worms (*Ancylostoma* and *Necator*), or (3) a capillary tube made up of a double row of large cells in apposition; this type is seen only in *Trichuris* (whip-worm) and *Trichinella*.

Oxyuris (Enterobius) vermicularis, or thread-worm. The male is about $\frac{1}{8}$th inch long and the female about $\frac{1}{3}$rd to $\frac{1}{2}$ inch. The male has a blunt ventrally curved tail with a single spicule, whereas the female has a long pointed tail. The egg-shell is ovoid, flattened on one side, it is thick and colourless and contains a partially developed embryo. When the female reaches the egg-laying stage she frequently migrates out through the anus and deposits her eggs on the buttocks, whence they are conveyed to the mouth by contamination of fingers as a result of scratching. This scratching is induced by the peri-anal irritation caused by the migrating females. On reaching the intestine of the host a "weak spot" in the shell dissolves and the embryo escapes. Auto-reinfection in man is constantly occurring. It is necessary for the eggs containing embryos to be swallowed to produce a fresh crop of adult worms.

Filaria bancrofti. The adult male is about 2 inches long and the female 3 inches. They live in the lymphatics and glands

of man. The embryos are minute and enclosed in a sheath. They exhibit "nocturnal periodicity," *i.e.* during the night these embryos enter the peripheral circulation; during the day they remain in the lungs and larger arteries. If the individual alters his habits and sleeps during the day, the embryos eventually appear in the peripheral vessels only during the daytime. This phenomenon is apparently connected with the night-biting habits of the intermediate host, for the infection is transmitted by mosquitoes (*Culex fatigans*, etc.). When the mosquito sucks the blood of an infected person during the night the embryos enter its stomach. They then pass through a period of development, lasting fifteen to twenty days, in the muscles of the mosquitoes, and finally migrate to the proboscis. When the mosquitoes bite they find their way into the skin, as a rule at or near the site of the puncture. They eventually reach the lymphatics and grow slowly to maturity, taking about a year to do so. Associated symptoms are lymph-scrotum, hæmato-chyluria, elephantiasis, etc.

In certain of the Pacific Islands there is no nocturnal periodicity, and the vector is *Aëdes variegatus* (*pseudo-scutellaris*) and not *Culex*. Recently another species, *Microfilaria malayi*, has been described from the Middle and Far East. The intermediate host is a species of *Mansonia*.

Anti-mosquito measures are the only practicable means of prevention of these filarial infections.

Dracunculus medinensis or guinea-worm. The male, which is 1½ inches long, has not been found in man; the female is from 1 to 3 feet long. The pregnant females usually travel to the pendulous parts of the body, *e.g.* limbs, scrotum, mammary glands. In 90 per cent. of cases they erupt around the ankles. A small blister first appears over the head of the worm which, when the blister bursts, is seen in the centre of the resulting ulcer. An intense burning pain caused by the blister makes the patient lave the part with cold water and in this way the embryos escape from the ruptured female into the water. The embryos coil and uncoil in water and, forming a bolus, are swallowed by certain species of Cyclops (*C. quadricornis*, *C. viridis*, *C. coronatus*). After arriving in the intestine of the cyclops the embryos traverse the gut wall and reach the body cavity. In eight days or so they undergo their first moult, losing their tails, and in some five weeks they become mature. They attain a length of 1 mm. and lie in the body cavity of the cyclops. No further development takes place there, but when swallowed by man (as may occur when the pond or well is low, for the infected cyclops sinks to the bottom) the cyclops is digested, but not the worm, which goes on developing in the human host. Any form of filtration is preventive. Even simple filtration through linen is sufficient to hold back the infected cyclops. The con-

dition is met with especially in West Africa, the Sudan and in India.

Ascaris lumbricoides, or common round-worm, lives usually in the upper portion of the small intestine, The male is 4–8 inches long and the female 7–12 inches. The three fleshy lips have denticulate edges. The egg is elliptical in shape, with a thick and usually roughened surface. Unfecundated eggs are longer than the fecundated, and contain fatty *debris* instead of an ovum. The eggs when passed contain an unsegmented ovum. In moist earth the embryo develops within the egg in thirty to forty days ; in several months if the temperature is low. The egg with the embryo inside can live for a long time and can resist freezing or a temperature of 108° F., mainly on account of its thick shell, but cannot resist complete desiccation. Until the larva is fully developed and active it cannot infect man. The egg containing the larva is swallowed by man in contaminated food or soil. When the egg reaches the small intestine of man the larva, leaving the softened shell, perforates the wall of the small intestine, gains the liver, where it remains for three or four days, and finally reaches the lungs by the blood-stream. The larva bursts into the air sacs, and *via* the trachea and œsophagus eventually returns to the small intestine to become adult. If many larvæ are present they have been known to produce serious and even fatal pneumonia. (See Ministry of Health Report No. 31, 1925.)

Hook-worm. Two genera of hook-worm are represented in man, viz., *Ancylostoma* (*A. duodenale*) and *Necator* (*N. americanus*). Both occur in tropical and sub-tropical countries. They are differentiated by the shape of the mouth capsule which in *A. duodenale* is pear-shaped and in *N. americanus* is globular. The eggs of these two species are oval, thin-shelled and colourless and cannot be distinguished microscopically. A third species *A. brasiliense* is normally a parasite of dogs and cats but the larvæ can produce dermatitis by entering the human skin.

Acylostoma duodenale. The male hook-worm is about 10 mm. long and the female 10–18 mm. They are whitish in colour and are found in the intestine of human beings, especially in the jejunum, where they attach themselves to the mucous membrane by means of a mouth capsule with four teeth. The eggs are about 50–60 μ in length, and when passed in the fæces usually show 4–8 segments. Further development is aided by moisture, supply of oxygen and a temperature of 70°–90° F. Under such conditions a small embryo appears coiled up inside the egg in twenty-four hours, and within a week it is hatched out as a larva. The larva passes through two moults before becoming infective. It may then live in damp ground for months, but cannot withstand desiccation or direct sunlight.

In the tropics the infective stage for man may be reached in four to five days. The larvæ enter human beings usually through the hair follicles and sweat glands, especially on the feet, setting up what is known as "ground itch." They pass immediately into the veins, and on reaching the lungs they rupture the capillaries and pass into the air-cells. From there they ascend the trachea and then descend the œsophagus to the stomach and intestine. This migration occupies ten to twelve days. Within about two months of the larvæ reaching the intestine, eggs appear in the fæces. The main symptoms are anæmia, due to the sucking of blood by the worms and to blood loss from minute bites, joint-pains, lethargy, dyspepsia and œdema. There is a fair degree of eosinophilia (10–20 per cent.) in recent infections. Detection of the eggs in the fæces is the only sure method of diagnosis. Preventive measures are good sanitation and the treatment of carriers, avoidance of skin contamination especially by protecting the feet by boots. Thymol and oil of chenopodium, formerly much used in treatment, are being replaced by carbon tetrachloride and tetrachlorethylene. The advantage of this latter form of treatment is that no preliminary dietetic preparation is required as the drug also acts as its own purge. The disease is common in the zone lying between 36° north and 30° south of the equator. It has been met with in Britain only in workers in the Cornish tin-mines.

Necator americanus. This hook-worm is more widespread in the tropics and more prevalent than *A. duodenale*. In spite of its name, it is not confined to the New World, as it is found in America, West and Central Africa, India, Ceylon, China, Australia and the Pacific Islands. The male measures 7–9 mm. and the female 9–11 mm. The buccal capsule has two lateral cutting plates in place of the teeth characteristic of *A. duodenale*, but the eggs of the two species are practically indistinguishable. The life-cycle is the same.

Trichuris trichiura (*Trichocephalus dispar*), or whip-worm (so-called from its thick body and lash-like neck) is found usually in the cæcum of man, with its neck buried in the mucous membrane. It is about 2 inches long. The eggs are barrel-shaped, thick-walled, with a plug at each end. Auto-infestation does not occur, because the egg when passed in the fæces does not contain an embryo and is not formed till from six weeks to twelve months. It can survive within the shell for many months. When the embryo has sufficiently developed, man is infected by ingestion. The shell plugs dissolve in the gastric juice and the embryo escapes and attains maturity in the large intestine.

This parasite is the commonest of all in the human intestine. Its distribution is world-wide, but heavy infections are very

seldom seen and no clinical symptoms have been definitely associated with its presence.

Trichinella spiralis. The adult form lives in the submucosa of the small intestine of the pig, wild boar, bear and rat, as well as of man. The female is 3–4 mm. long and the male 1·5 mm. The embryos are deposited directly in the lymph spaces of the intestinal wall, whence they pass to the blood-stream and so to the muscles. They enter the muscle fibres in about two weeks and in six weeks develop into encysted larvæ. These larvæ are about 1 mm. long, and lie coiled up in the tiny cysts. There may be as many as four in one cyst. In the course of time the cyst wall becomes fibrous, and lime salts may be deposited in it; this calcification takes place in about six months. Encysted larvæ may remain alive for twenty-five years. For the cycle to be completed the raw or imperfectly cooked flesh must be eaten by another animal. The liberated larvæ then enter the small intestine, become sexually mature about the third day, and on the seventh day the first embryos will probably be discharged by the female. It takes about another fortnight for the migration of the embryos to the muscles to complete itself. In the pig, which shows few clinical symptoms, the muscles most frequently affected are the diaphragm, shoulder muscles, intercostals and tongue (see p. 382). In man severe symptoms may appear. Gastro-intestinal trouble may occur in the early stages, and during the migration of the embryos, fever and œdema, with severe muscle pains, are frequent. The blood usually shows an increase of eosinophiles even up to 70 per cent. Diagnosis is best made by examination of a small portion of the deltoid muscle.

Platyhelmia

The flat-worms are divided into flukes and tapeworms. The former (Trematoda) are leaf-like or pear-shaped and have a gut which always ends blindly; the latter (Cestoda) are tape-like, made up of segments which correspond in certain morphological characters to single flukes. They have no gut.

The flukes as a group are hermaphrodite but species of the genus *Schistosoma* are unisexual. All flukes require a mollusc as first intermediate host and in some the infective stage encysts in a second host. Whereas in the hermaphrodite flukes the gut is forked and ends in two cæca, in the Schistosomes these two branches of the gut unite again to form a single cæcum. Moreover, whereas the eggs of the hermaphrodite forms have a lid or operculum, those of the Schistosomes have no lid and explode on immersion in water.

Of the flukes, only one, *Fasciola hepatica*, occurs in man in Britain and then only as an accidental infection. Having entered an abnormal host, it sometimes fails to reach the

human bile ducts and forms abscesses under the skin. It is, however, a common parasite of sheep, cattle, horses, rabbits and sometimes occurs also in pigs. It is heart-shaped, about $1\frac{1}{4}$ inches long and gives rise to large oval thin-shelled eggs with ill-defined operculum.

Schistosoma hæmatobium and S. mansoni produce the condition known as Bilharziasis. The adults of the former live in the portal, vesical, hæmorrhoidal and uterine veins, and the adults of the latter are found chiefly in the mesenteric veins and branches of the portal vein in the liver. The male worm is about $\frac{1}{2}$ inch long and carries the longer, slender female in a ventral groove, the "gynæcophoric canal." The eggs are about 0·16 mm. long and oval in shape. In *S. hœmatobium*, the eggs have a terminal spine and are found in the urine, occasionally also in the fæces, while those of *S. mansoni* have a lateral spine and appear in the fæces. The eggs are deposited in the smaller vessels of the submucosa and tend to cause local ulceration, probably due to some secretion of the egg, with irritation and subsequent fibroid change.

The egg contains a ciliated embryo (miracidium), which escapes when the egg reaches water. It dies within twenty-four hours if it cannot enter certain fresh-water snails. Within the snail the miracidium loses its cilia and becomes a sporocyst, which in time produces many daughter sporocysts. These finally give off little tadpole-like cercariæ with bifid tails. The cercariæ are discharged from the snail into water where they can survive only for twenty-four to forty-eight hours, within which time they must find a human host or die. Cercariæ enter the human body either through the skin or through the buccal mucous membrane and on entering the veins are conveyed by the blood through the pulmonary and mesenteric capillaries to the veins of the liver, where in about eight weeks they develop into sexually mature adults. *S. hœmatobium* is found in Africa, Palestine, Mesopotamia, Arabia, Cyprus and Western Australia, while *S. mansoni* has been discovered in Africa, West Indies, Brazil, Venezuela and Dutch Guiana. Neither species occurs in Asia. Symptoms resembling urticaria are produced by the cercariæ at the time of invasion. Three or four weeks later there may be high temperature, general malaise and weals due to toxins absorbed from the growing worms. Pathological changes, with blood in the urine, or diarrhœa, with ulceration of the rectum, appear at least three months after infection in the case of *S. hœmatobium*, and in four to eight weeks in *S. mansoni*. The liver and spleen may become enlarged, and anæmia is often severe. Storage of water for forty-eight hours gives protection. Acid sodium sulphate (1 : 1,000), filtration through Pasteur-Chamberland, Stella or Meta Filters, or boiling is advised. Liquor. cresol. sap.

(1 : 10,000) immediately or 1 : 90,000 over-night renders water safe for bathing. Chloramination 3 parts per million for sixty minutes is also effective.

S. japonicum has a habitat in man similar to that of *S. mansoni* but has several reservoir hosts—cat, dog, cattle, field mice. The egg has a recessed knob but no spine. This infection is peculiar to Asia and is prevalent in Japan, China, the Shan States and the Philippines.

The hermaphrodite flukes occur chiefly in Asia, with the exception of the small duodenal fluke *Heterophyes heterophyes* which is found in Egypt as well as in the Far East. The clinically important members of this group are the Asiatic liver fluke *Clonorchis sinensis*, acquired by eating freshwater fish, and the lung fluke *Paragonimus ringeri*, transmitted in the flesh of freshwater crabs and crayfish.

The tapeworms of man belong to two categories, viz., (1) the *Pseudophyllidea*, which have two slits or sucking grooves on the head. The eggs have a lid or operculum and are discharged from a birth pore in the middle of the segment. They contain an unsegmented ovum surrounded by yolk cells. This group is represented by *Dibothriocephalus latus* (Diphyllobothrium latum). The adult form may be 18 feet long, and is found in the intestine of man and dog. Each mature segment has a rosette-shaped uterus. The eggs are passed in the fæces. The embryo develops within the egg in water after being passed, taking ten to fifteen days at 86°–95° F. The embryo escapes by the operculum and swims about for several hours until ingested by its first intermediate host, a crustacean (*Cyclops strenuus* or *Diaptomus gracilis*). It passes into the body cavity of the cyclops and becomes a procercoid larva, attaining maturity in two to three weeks. More than one may develop in the same cyclops. Infected cyclops are ingested by a fresh-water fish (pike, perch, salmon, trout, etc.). The procercoid then penetrates the intestinal wall of the fish, to encyst in various organs and develop a new head, usually in the mesenteric tissues, testis or ovary, more rarely in the muscles. This larva, called a plerocercoid, may measure half an inch in length. Man is infected by eating fish badly cooked or raw in the form of caviare. These larvæ are killed in a few minutes at 122° F. It is necessary to boil infected fish, even if caught a few days before, as the larvæ survive the death of their host. The larva becomes an adult after three weeks in the human intestine and may live for five years or longer. Fish are infected through contamination of water with sewage and probably from animals, *e.g.* dogs and bears, which also harbour this tapeworm. The countries mainly affected are Russia, the Baltic States, Siberia, Switzerland, Japan, Canada and the Northern States of the U.S.A. around the Great Lakes.

(2) The *Cyclophyllidea* which have four round suckers on the head; the eggs have two shells, are without a lid and are retained within the segments owing to the absence of birth pores. The copulatory genital pores are situated on the margin of the segment. The eggs contain an embryo with six hooklets. To this group belong the genera *Hymenolepis*, *Tænia* and *Dipylidium*. These three genera can be distinguished by the following characters: *Hymenolepis* has a single crown of small hooks on the head, the genital pore is on the same margin in every segment and the outer and inner shells are clear. The mature segments are filled with embryonated eggs contained in an oval uterus. The eggs when swallowed from fæces hatch in the intestine and larval development, in minute cysticercoids, takes place in the villi of the duodenal mucosa. The cysticercoids eventually burst out and grow into adult worms in the lumen of the intestine. Man is therefore both definitive and intermediate host and may harbour very large numbers of this tapeworm. *H. nana* which measures only 12–25 mm. long is common in man in Egypt, India and the United States. Sporadic cases have been reported elsewhere. It has so far not been recorded from Britain although a morphologically identical form occurs in mice. The genus *Tænia* has a double crown of large hooks on the head, but in *Tænia saginata* the head has no hooks. The genital pore alternates irregularly from side to side in each segment. The embryonated eggs have a very thin outer shell which collapses around an inner shell which is thick and radially striated. The mature segments are filled with a branched uterus. There are two species of *Tænia* in man —*T. solium* and *T. saginata*, the eggs of which cannot be distinguished microscopically. These species are differentiated on the heads and gravid segments.

Tænia solium. The adult worm is 6–9 feet long and is found in the intestine of human beings. The mature segments are about 1 cm. long by 7–8 mm. broad. Although each segment is hermaphrodite, the male organs disappear before the segments become mature. The ripe segments which have only 9–12 lateral branches to the uterus become detached and pass out in the fæces and may be eaten by an intermediate host. A limited number of eggs are given off from the terminal segment and these may be found occasionally in the fæces. To complete its development the egg must be swallowed by a pig. The eggshell is then digested and the embryo set free. By the lymphatic system it eventually reaches the muscles (tongue, neck, shoulder and diaphragm), brain, eye, etc. and, losing its hooklets, develops into a bladder-like larva (cysticercus) with an invaginated head or scolex, armed with hooks. These cysts are usually the size of a pea. Pig flesh infected in this way is known as "measly pork." Man is infected by eating such

meat. Cysticerci have been found alive four weeks after slaughter of a pig. It is doubtful if cold storage is protective unless unduly prolonged. Only thorough cooking should be relied on. It must be remembered that man is also liable to become accidentally infected with the cysticercus stage by swallowing eggs from his own infective fæces. The worm is now rare in this country, but is found still in North Germany, Cyprus, Transvaal, India, etc. Many cases of cerebral cysticercosis have been reported in British soldiers who have served in India. Involvement of the brain with cysticerci may give rise to epileptic fits.

Tænia saginata. Man is the host of the adult worm which is usually from 15 to 16 feet long. The head which has no hooks is larger than that of *T. solium*, is square and measures about 2 mm. The mature segments are filled with a uterus having twenty to thirty lateral branches. The eggs are ingested by cattle, in the muscles of which the cysticercus stage takes place, producing "measly beef." The site of election of the cysticercus is the fatty tissue about the voluntary and the cardiac muscles. The cysticerci are difficult to see because they are usually few in number and resemble closely the fat globules in which they are engulfed. They may live for eight months. If man eats such beef imperfectly cooked the cycle is completed, the adult worm with sexually mature segments developing in two to three months. The condition is common in this country and in other beef-eating countries, *e.g.* Abyssinia, Kenya, etc. As the cysticerci die within three weeks of the slaughter of their host, cold storage is probably a safeguard. Salting is also said to be protective. But thorough cooking is the obvious safeguard in countries where meat inspection is not rigid.

Dipylidium caninum is a common parasite of town cats and dogs but occurs only rarely in man. The head has several rows of thorn-shaped hooks. In the mature segments the eggs are in "nests."

Certain cestode larvæ may develop occasionally in man. (*a*) The larval stage of *T. solium* (Cysticercus cellulosæ), which normally develops in the pig, may also develop in man and cause cerebral symptoms (Jacksonian epilepsy), and (*b*) the larval stage (hydatid) of *Tænia echinococcus*, which forms normally in cattle, sheep, horses, pigs and other mammals, occasionally develops and produces serious symptoms in the lung, liver and spleen of man.

Tænia echinococcus. The adult worm, 4–5 mm. long, and consisting of only three or four segments, it never occurs in man and is found only in the intestine of the dog, fox, wolf and jackal. The head has four round suckers and a double row of hooklets. Only the terminal segment is mature. When the eggs are consumed by sheep, pigs, oxen, horse or man, the six-

hooked embryo is liberated and bores its way into the lymphatic circulation. It settles in the liver, or it may pass to the lungs or brain. In any of these places it may spend the rest of its larval stage, losing its hooklets and developing into a thick-walled cyst with an external laminated and an internal germinal layer. This cystic form is known as a hydatid cyst. It is filled with clear fluid, and in the course of time brood-capsules grow from the germinal layer. From the wall of these brood-capsules scolices (really complete heads of *T. echinococcus*) develop, and each scolex is capable of growing into the adult worm if eaten by a dog. The parent cyst may have daughter cysts within it, and these, again, grand-daughter cysts, so that from one embryo thousands may be produced. Dogs tend to become infected in such places as slaughterhouses, and man may be infected from dog fæces when he lives in close association with dogs, as in sheep-farming countries.

INSECTS OF MEDICAL IMPORTANCE

Mosquitoes may be distinguished from numerous other two-winged insects by the presence of scales on the wings, and by the possession of a proboscis which in the female is adapted to sucking blood.

Life-history. There are four stages: (1) egg; (2) larva; (3) pupa; and (4) adult mosquito or imago. The first three are aquatic. The eggs (about 1 mm. long) are laid on the surface of water either singly or in rafts. The eggs hatch out into larvæ, which come to the surface of the water to rest or breathe, but at other times move rapidly about with a wriggling motion. The larva passes through several moults, and then becomes a pupa, like an exaggerated comma. This stage is passed without food. At the end of this time the pupal case splits and the adult mosquito emerges. From egg to adult occupies usually two to three weeks, but the influence of atmospheric temperature is marked. In temperate climates the duration of the early stages may extend to months. It is the females that suck blood, which is necessary for the proper development of the eggs. Each female can lay between 100–200 eggs at a time, and more than one batch may be laid. Mosquitoes may travel several miles from their breeding-places.

Classification. The principal genera of medical importance are (*a*) *Anopheles*, certain species of which transmit malaria (*e.g. A. maculipennis* in Europe); (*b*) the common brown domestic *Culex fatigans*, an important transmitter of *Filaria bancrofti*; (*c*) *Aëdes ægypti* (or *Stegomyia fasciata*) which transmits yellow fever and dengue.

The main points of difference are as shown in the following table.

The principal anophelines found in England are *A. maculipennis* and *A. bifurcatus*. Both can transmit the malaria parasite. The former is the one most frequently found in

	Anopheles.	Culex, Aëdes, etc.
Adults—		
Resting position	The body and head in a straight line.	Head and body inclined at an angle to one another.
Wings . .	Frequently spotted.	Usually plain.
Palpi . .	As long as the proboscis in both sexes.	Very short in the female, like two small knobs.
Eggs . . .	Laid singly with air floats.	In rafts or singly, no floats.
Larvæ . . .	Small head. No respiratory siphon. Lie flat along the surface when they breathe.	Large head. Long respiratory siphon. Hang downwards when they breathe.

houses, and during the winter the species is continued by the survival of fertilised females in cowsheds, cellars, etc. *A. bifurcatus* passes the winter in the larval stage. Malaria used to be prevalent in the Fen districts of England, and towards the end of the war (1914–18) indigenous cases began to occur in the neighbourhood of the estuary of the Thames and on the Kentish coast. An occasional indigenous case is still notified.

Control of Mosquitoes

1. *Adults*. (*a*) Hand-catching with nets, etc., inside houses.

(*b*) Spraying with a paraffin and pyrethrum liquid. Most effective during hibernation.

2. *Larvæ*. (*a*) Abolition of possible breeding-places by draining or filling.

(*b*) A weekly emptying and drying of all household water vessels.

(*c*) Covering over collections of water, *e.g.* storage tanks. If wire gauze is used, the mesh should be eighteen to the linear inch.

(*d*) Application of larvicides to collections of water, *e.g.* a mixture of diesel oil and kerosene if spread over the whole surface in an unbroken layer. One teaspoonful of commercial cyllin per gallon of water kills larvæ in a few minutes and pupæ in less than half an hour. Paris green 1 per cent. mixed with very dry road dust is a useful larvicide, especially if much vegetation is present; it does not harm fish, animals or plants. It is effective only against *Anopheles*. Paris green should

contain at least 50 per cent. of arsenous oxide and should not be more than 3 per cent. soluble in water.

(*e*) Clearing vegetation out of pools and making the edges hard and smooth. This renders pools unattractive to female mosquitoes when seeking a place in which to lay their eggs.

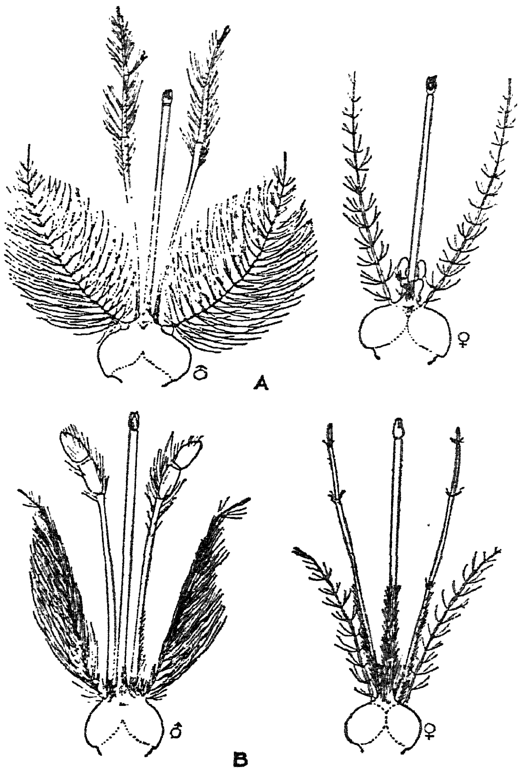


FIG. 2. A, Heads of male and female culicine.
B, Heads of male and female anopheline.
(After Giles.)

(*f*) Stocking ponds with larvæ-eating fish, *e.g.* sticklebacks, top minnows, goldfish, "millions" (*Gambusia affinis*). This method is not fully effective unless vegetation is removed from the pool. *Gambusia* are as susceptible to overchlorination as to overcrowding. A chlorine dosage with a residual of 0·1 to

0·15 part per million is tolerated. A film of kerosene on the water does not harm them. (U.S.P.H.S. Report, Vol. 56, No. 23, 6th June, 1941).

(*g*) Hydro-technical control embraces measures by which the area, depth, flow or tranquillity of mosquito-breeding water is altered to check or abolish breeding. Automatic flushing of streams or open channels by syphons has given excellent results. A large volume of water is discharged with the object of causing a wave down the channel or stream. This effects an economy in oiling, is not destructive of vegetation and where necessary permits growth of shade plants along the banks. (*J. Roy. San. Inst.*, November, 1937, pp. 345–350, Scharff.)

It is obvious that measures directed against the breeding of the local species of mosquito known to convey malaria are likely to give more satisfactory and permanent results than the killing of a few adults. In cases where it is impossible to deal with the problem at its source, houses should be made as mosquito-proof as possible and bed nets should be employed (see p. 113). For the screening of buildings a 14-mesh screen-cloth made of wire of 30 Imperial Standard Wire Gauge should be used. This gives a maximum amount of light and air compatible with safety, at least against most sorts of mosquitoes. For the screening of water containers which breed mosquitoes an 18-mesh screen-cloth made of 30 or 28 Imperial Standard Wire Gauge may be used. ("British Mosquitoes and their Control," British Museum, Natural History, Economic Series No. 4A, 1934; *Annals of Trop. Med. and Paras.*, 22nd October, 1937, p. 447, Blacklock; "Mosquito Control," Herms, W. B., and Gray, H. F., Commonwealth Fund, New York, 1940; "Malaria Control by Anti-Mosquito Measures," 2nd ed., 1941, Covell, G.).

Phlebotomus papatasii conveys the infection of sand-fly fever in the Mediterranean area, India, etc., and of Kala-azar. It is a tiny brown midge and very hairy. It passes through the stages of egg, larva and pupa before reaching adult form, the whole cycle occupying six to twelve weeks. It is found in all stages in holes and crevices where moisture is present. The winter is passed in the larval stage. The female sucks blood before ovipositing. The range of flight of the adult is very small. To protect against this insect a net with a mesh of at least twenty-two to the linear inch must be used.

Glossina palpalis, *G. morsitans* and other species of tsetse-fly carry the trypanosomes of sleeping sickness in tropical Africa. The female does not lay eggs but gives birth to a mature larva which at once crawls away to some place where it immediately pupates. Both sexes feed on blood and will attack man or animals. When resting, the wings overlap like scissor blades.

Prophylactic measures include the prevention of contact between man and the fly by the mass movement of natives to non-infected areas, the clearance of scrub from the neighbourhood of houses, drinking pools, etc., and the trapping of the fly itself. Early diagnosis and treatment are essential.

Musca domestica, or common house-fly, forms 90 per cent. of all flies caught in houses in Britain. The adults become sexually mature in ten to fourteen days, and the female begins to oviposit four days after mating. Eggs are laid in batches of 120, and four to ten such batches may be laid by one female in a season. The favourite site is on the surface of fermenting vegetable matter or fresh dung of horse, pig or man. Each egg is about 1 mm. long, white, shiny and cigar-shaped. The larvæ or maggots appear in from eight hours to four days, according to the temperature. They are narrow and whitish, with a pointed head and rounded posterior. They are very active, and begin to burrow at once. In five to eight days, after two moults, they become full grown (about ½ inch long). At this stage they are found usually a few inches below the surface of the refuse. They then leave their feeding-ground at night and seek a drier spot, frequently in the surrounding earth or at the top or sides of midden walls. Here they develop into cylindrical, motionless pupæ of a chestnut colour, the pupal stage lasting for a few days or as long as two to four weeks. At the end of this time the flies emerge and make their way to the surface, if the pupæ have developed below ground. The wings are crumpled at first, but in little more than an hour the flies are capable of flight. From egg to adult fly occupies about three weeks in English summer weather; in the tropics the period may be as short as a week. The total range of flight is at least one mile in urban areas.

Flies feed on manure of many animals, including man; also on sugar, bread and other foods which we eat without further cooking. They may convey infection in various ways. They deposit vomit and fæces on everything on which they alight. In addition, when feeding on solid material, they attempt to soften it by means of vomit and saliva. Pathogenic organisms may survive in the crop for several days and thus infect the vomit. Their fæces, too, may be dangerously infected. Flies may also carry various organisms on the hairs, especially of the legs; such organisms may survive for several hours. In these ways many diseases may be spread, *e.g.* typhoid and paratyphoid fevers, epidemic diarrhœa, the dysenteries, and possibly cholera, anthrax, tuberculosis and other infective disorders. (*Medical Officer*, 22nd February, 1941, p. 65, "A Fly-borne Epidemic of Enteric Fever," Baker Jones, E.)

Preventive measures. 1. Removal of all refuse, etc., from the neighbourhood of dwellings. What cannot be removed at

once should be covered. This will abolish breeding-places and is the most important measure.

2. Proper storage and protection of food. This makes feeding less easy within doors and prevents infection.

3. Destruction of flies (where more thorough methods are not possible) :—

(*a*) Tangle-foot traps: wires or papers smeared with a mixture of well-boiled castor oil and resin in the proportion of five to eight. Various other traps have been devised and answer well.

(*b*) An effective poisonous mixture consists of 2 tablespoonfuls of formalin, 1 heaped tablespoonful of sugar, half a pint of clear lime water and water to make up 1 pint. Absorbent wicks or strips of blotting paper may be kept moistened with this mixture.

(*c*) Hand-killing by means of "swatters."

4. Destruction of larvæ in manure :—

(*a*) By close-packing the manure and relying on the heat of fermentation to destroy the larvæ (122° F. kills in three minutes). The heat of fermentation may be usefully conserved by covering the manure with tarpaulins, or by collecting the manure, when fresh and therefore most dangerous, in concrete receptacles.

(*b*) Trapping the migrating larvæ in special gutters.

(*c*) Application of a solution of borax, ½ lb. in 2 or 3 gals. of water, to every 9 cubic feet of manure, especially at the edges of the pile. (British Museum, Natural History, Economic Series No. 1, 1939.)

Blue-bottle flies (*Calliphora*) and **Green-bottle** (*Lucilia*) frequently deposit eggs on meat, both fresh and cooked. They may cause myiasis of wounds.

Stable Fly (*Stomoxys calcitrans*) resembles the house-fly but has a spotted abdomen, is a blood sucker and is furnished with a sharp needle-like proboscis. This fly feeds on mammalian blood, preferably that of horses and cattle but sometimes of man. It is found chiefly in farm yards and stables and lays its eggs in manure and fermenting vegetation. It probably acts as a vector of other diseases including anthrax, tropical sore and surra, an important veterinary disease due to *Trypanosoma evansi*.

Lice. It has frequently been stated that the lice occurring on the head and body of man are distinct. It is now known however that the differences are inconstant, so that it is often impossible to refer a louse to one or other type. The biological differences are also very slight. One should therefore say that there is one species of *Pediculus*, *P. humanus*, and that it exists in two barely distinct biological races—the head louse (*P. humanus capitis*) and the body louse (*P. humanus vestimenti*).

Pediculus humanus vestimenti lives on the body or clothing

of its human host. The female lays some 250 eggs within about a month, attaching them by a sort of cement to fibres of the clothing, especially around seams. Occasionally they may be laid on the pubic or axillary hairs. The eggs are yellowish, glistening and about the size of a pin's head. They hatch out in eight to twelve days into nymphs or larvæ, which are really small editions of the adults. These moult several times and become sexually mature in about two weeks. Lice may live for a week without feeding, and the eggs or nits may retain their vitality for a month in clothing that has been laid aside.

Pediculus humanus capitis usually remains in the head, but may be found on other parts of the body. The female attaches its eggs to the hairs of the head.

An interesting investigation into the incidence of head lice in England was undertaken recently and the results of approximately 60,000 observations in ten industrial cities (seven cities with over 400,000 inhabitants and three county boroughs) indicate :—

(*a*) that a very high degree of infestation with head lice exists in the industrial cities ;

(*b*) that girls are more frequently infested than boys ;

(*c*) that the highest rate of infestation is found among pre-school age children ;

(*d*) that whereas the infestation among boys decreases steadily from about three years (where over 40 per cent. are verminous), until the infestation among young adult males is very low, in girls there is practically no decrease before the age of thirteen, and even the older girls over thirteen show a considerable degree of lousiness ;

(*e*) little support is given to the commonly-held idea that the aged are frequently verminous. Those over seventy years showed a percentage of lousiness similar to the other adults. (*Medical Officer*, 1st February, 1941, pp. 39–43, Mellanby, K.)

Phthirus pubis, or crab-louse, may be found on any hairy part of the body, but lives particularly in the neighbourhood of the pubic and anal regions and deposits its eggs on the surrounding hairs. The crab-louse may be distinguished from *Pediculus* because it is nearly circular in outline, with the head impacted in the thorax. *Pediculus* is elongate, with the head completely free from the thorax. It is difficult to detect, but frequently bluish-grey spots on the skin give an indication of its presence. The life-histories of these two species are much the same as that of the body-louse.

Lice cause considerable irritation, especially in persons who have no means of changing their clothing or of bathing frequently. They produce a state of lowered vitality on account of loss of sleep, particularly among young children, and skin diseases such

as impetigo may be due to their presence. *P. humanus* conveys the infection of typhus, relapsing fever and trench fever. (British Museum, Natural History, Economic Series No. 2a, 1942.)

Disinfestation. Both the infested individual and his clothing must be dealt with at the same time. A thorough washing of the body and head with soap and water, followed by fine combing and shaving of the hair of the pubis, chest and axilla, should remove the lice and nits.

To destroy the head louse it is advisable (but not necessary) to shorten the hair. In treating a head the following should be noted : All unhatched eggs are close to the scalp and the lice must go there for food ; the insecticide should, therefore, cover all of the hairy scalp ; there is no need to saturate the hair at a distance from the head ; to avoid unpleasant appearance the volume of insecticide should be as small as possible.

The following insecticides may be used : (1) 25 per cent. technical lauryl thiocyanate in a white oil ; (2) 50 per cent. lethane 384 special, similar oil (this has been added to the National War Formulary) ; (3) derris cream. The dose for any of these is 0·5–2 drachms (about 2 to 8 c.cm.) a head. The lowest dose is sufficient for a child with short hair and the highest for a woman with long hair. The amount recommended is approximately that which would be applied as brilliantine or other hair oils in general use. In applying any of these preparations the hair is parted with one hand and the liquid or cream is put on the scalp at eight spots, four on each side, with a teaspoon or pipette held in the other hand. The material is distributed by massaging with the fingers. A comb should not be used as it draws the insecticide away from the scalp. The head should not be washed for ten days. Another effective preparation which will kill head lice and their eggs is a mixture of 7 parts of methylated spirits and 3 parts of water. Not more than one fluid ounce is required for a child's head and half this amount is ample for a boy with short hair. The hair dries in a few minutes and need not be washed. This dilution is not readily inflammable, does not harm the scalp, and the method is both simple and cheap. Other useful applications are cresol or lysol, either of which is efficient if applied to the hair for not longer than twenty minutes. A 1 in 40 watery solution of carbolic acid is also recommended.

Clothing may be dealt with by either dry or moist heat. Heat kills lice and nits in five minutes at a temperature of 131° F. Recently a powder, the composition of which is secret for reasons of security, has proved to be the best disinfesting agent so far discovered. Persons dusted with this powder are rapidly freed from lice, and their clothing, if it retains the powder, remains louse-deterrent for some weeks.

An emulsion of 2 per cent. cresol with 5 per cent. soap will kill lice and their eggs when immersed for one hour ; leather and rubber articles may be disinfested in this way. Lice will survive sixty hours' immersion in plain water, and twenty-four hours in a 7 per cent. solution of bleaching powder. Ironing of the seams of clothing with an ordinary laundry hot-iron is also effective. ("The Louse," Buxton, P. A., Arnold & Co., 1939 ; Min. of Health Memo., 230/Med., 1940, 252/Med., 1941, 230A/Med., 1943, and Circular 2831, 1943.)

Fleas. *Pulex irritans* is the flea that most commonly attacks man. *Xenopsylla cheopis* is the most important of the rat fleas that convey the bacillus of plague from rat to man. The eggs are laid singly. They fall on the ground, and are found especially where the host animals sleep. In two to four days in summer, and in about two weeks in winter, they hatch out into whitish, footless, slightly hairy larvæ. The larva feeds on the organic matter in the dust of the floor, and is full grown in about a fortnight. It then spins a cocoon and becomes a pupa. At the end of another two weeks the adult emerges. Under certain conditions and at lower temperatures the life-history may be greatly prolonged.

When the rat flea sucks plague-infected blood the bacilli multiply in its stomach, and the mass of bacilli finally blocks the œsophagus. A flea in this condition, when it endeavours to suck more blood, regurgitates some of this infected material on the skin of its host. In this way the bacilli may enter through the bite. The organisms are also found in the fæces of the flea, and may be rubbed into the puncture wound. Rat fleas have been known to remain infected with *Pasteurella pestis* for forty-three days.

Destruction of fleas. Close all the windows, etc., of the room, sprinkle naphthalene everywhere, and leave the room closed for a day or two. Then shake all mats in the room and collect and burn all the dust. A spray of paraffin (1 in 20) emulsified with soft soap in water is useful. (See British Museum Natural History, Economic Series No. 3, 1937.)

Cimex lectularius, or bed bug. During the day bugs usually remain hidden in cracks in the walls, floor, beds, etc. Eggs are laid in small clusters and attached to the sides of such crevices. Their development and the rate of hatching out depend on temperature, the mean period being forty-nine days. The eggs are unlikely to hatch at temperatures remaining below 13° C. and their survival through the winter in unheated houses is very improbable. A temperature of 45° C. (113° F.) kills the eggs in one hour and adult bugs are killed by a temperature of 44° C. in the same time. The larvæ resemble the adults, and after moulting several times become full-grown bugs within about six weeks of the hatching of the eggs. In another two

weeks they are sexually mature. Bed bugs can live without food for about one year and even longer under certain conditions. Blood of mammals and birds is the only food which bugs can take at any stage in their life-cycle. See p. 224 as to means of destruction of bed bugs. (British Museum Natural History, Economic Series No. 5, 1937.)

Sarcoptes scabei, or itch mite. The female burrows into the skin as far as the malpighian layer, depositing eggs as it goes, and in two or three weeks dies at the end of the tunnel. About twenty-four eggs may thus be laid. In about seven days the eggs hatch into larvæ, which moult and become nymphs in sixteen days. In another five days the mites are sexually mature ; the females become fertilised and the males die. The whole cycle is completed in four weeks. The condition is usually associated with lack of cleanliness. There is an incubation period, marked by absence of symptoms, which may extend over several weeks during which the parasite is establishing itself. The sites of irritation are those in which the *Sarcoptes* are found in greatest numbers. The rate of infestation varies. In one series of patients it was under 10, while in isolated cases there may be hundreds of parasites often causing little discomfort. The diagnosis of scabies can be made in 9 out of 10 cases by finding the *Sarcoptes* in the skin of the hands, the wrists or the elbows. In a person who has not previously had scabies the itching is not due to the burrowing of the parasites but to a sensitisation which takes place later.

In ordinary circumstances bedding can be practically ignored as a possible means of spread. Close contact between the skin of the patient and an infected person for a short time is not likely to produce infection, but if these people sleep together the risk is high. The explanation of this is that the *Sarcoptes* are in coma at a temperature below 61° F. and show little movement at a temperature below 68° F.

Storage of clothing at ordinary temperatures for two weeks will eliminate all parasites and laundering is also effective. During the incubation period it is often possible for an apparently healthy child to spread the disease to other members of the household. When the patient is a school child it is probable that other members of the family will be infested and it is therefore advisable for the whole family to be treated for scabies simultaneously under proper supervision. The prevention of scabies is best attained by unceasing vigilance, early diagnosis and rapid treatment of every case.

While there are many methods of treatment the following are those recommended by the Ministry of Health :—

(*a*) *Sulphur Ointment.* (Two-thirds B.P. strength.) Care should be taken to see that this is not over-applied as it may give rise to severe itching dermatitis, often thought to be due to the

continuation of parasitic infection. The patient should first have a bath in which he should soak for ten minutes, making use of a rough flannel but *not* a nail brush. After drying, the ointment should be rubbed in from the neck downwards, paying particular attention to the backs of the hands and the webs of the fingers, which are often neglected. For the average adult 2 ozs. should suffice, and the application takes about twenty minutes. Three applications with sulphur ointment on successive days without a further bath should clear up the condition. A hot bath must be taken on the day following the last application. One such treatment is usually sufficient, but in any case it should not be repeated for at least a fortnight. The patient should be warned that itching may persist for some days after the complete suppression of the parasites. The presence of new follicular papules surrounding the old burrows is an indication that active *Sarcoptes* are still present.

(*b*) *Benzyl Benzoate Emulsion.* (25 per cent.) The preliminary treatment is the same. After the patient is dried benzyl benzoate emulsion is applied over the whole body from the neck downwards with an ordinary flat paint brush, 1½ to 2 inches wide. The application is allowed to dry and the patient puts on clean underclothing. Mellanby states that in 99·9 per cent. this treatment is successful with one application. Benzyl benzoate is easy to apply and in clinics it would seem to be the method of choice.

Scabies was made notifiable in the area of the London County Council from 1st August, 1943, under regulations made by the Minister of Health. Under powers given by section 147 of the Public Health Act, 1936, a number of other local authorities have added scabies to their lists of notifiable diseases. The Scabies Order is noted on p. 542. (Min. of Health Memo. 229/Med., 1940, revised 1942; "Scabies," Mellanby, K., Oxford War Manuals, Oxford Univ. Press, 1943.)

Cockroaches, crickets and ants. The local authority is often asked for advice in exterminating these insects which frequently become a nuisance. Refuse dumps are often infested with crickets and when near residential property may be the cause of complaint. All these insects are attracted by food in every case; therefore, the strictest cleanliness in kitchens and larders, as well as of cooking utensils, is essential. The cockroach is perhaps the most objectionable as, apart from the food it eats, much more is tainted and spoilt by its body secretions.

As a preliminary measure all cracks and crevices, especially those around fireplaces and cupboards, should be sealed to prevent the insects from getting into the house, and care should be taken to see that skirting boards fit close to the floor. What-

ever insect powder is used, it should be persisted in to obtain results. The most effective insecticide for cockroaches, crickets and ants is sodium fluoride mixed with some attractive bait such as ground rice or meal. In future more use will be made of lethane 384 in a vapourised form for the destruction of all household pests. It does not corrode or stain metal fittings or polished furniture. The Bristol Sanitary Department is now using atomised lethane solution made up with thin odourless paraffin for disinfesting ship's crew quarters, cinemas, air raid shelters, hospitals and verminous houses. The following strengths are suggested :—

	Lethane in Paraffin
Fleas, house-flies, moths, etc.	6 per cent.
Crickets, beetles, cockroaches and blow-flies	8 ,, ,,
Bugs, lice and similar vermin	10 ,, ,,

(" Insect Pests," Harvey, W. C. and Hill, H., Lewis, Ltd., 1940 ; *Medical Officer*, 19th June, 1943, p. 198.)

MUNICIPAL AND COUNTY HOSPITALS

The Local Government Act, 1929 (see p. 5) altered the administration of the poor law and by the abolition of the boards of guardians made possible the unification of all the principal medical services, institutional and other, under the larger health authorities. County councils and county borough councils were authorised to " declare " that such services as the following would be provided in future under the Public Health and various special Acts and not under the poor law :—

1. Maintenance and treatment of sick persons and pregnant women in hospitals.
2. Maintenance of mental defectives in institutions.
3. Maintenance of blind persons in institutions and in their homes.
4. Maintenance and treatment of tuberculous persons in sanatoria and other institutions.
5. Education of children.

As a result of the coming into operation of the Local Government Act, 1929, county councils and county borough councils found themselves in control of a large number of institutions of various kinds. In England and Wales the institutions so transferred from boards of guardians contained at least 120,000 beds. As local authorities had already in their charge some 36,000 beds in isolation hospitals, 21,000 beds in sanatoria for tuber-

culous persons and 2,600 maternity beds in lying-in institutions, they became responsible for the management of about 180,000 beds for the sick (excluding beds in mental hospitals). In London alone the L.C.C. had, on April 1, 1930, to take over the administration of seventy-six hospitals containing over 42,000 beds and a staff of nearly 20,000.

Three methods have been provided for the removal of the institutional care of the sick from the poor law: (1) by "*assignment*," (2) by "*appropriation*" and (3) by "*declaration*." Where it is not practicable to segregate the whole or part of an institution from other buildings continuing to serve the functions of the poor law, a method of unifying the medical services is provided in Section 4 (4) of the Poor Law Act, 1930. This section permits a local authority to arrange for any of the transferred functions to be discharged, on behalf of and subject to the general direction and control of the public assistance committee, by any other committee of the council. This method is called "*assignment*." Even such a typical poor law service as that of domiciliary medical treatment may be administered in this way, but little use has been made of this power up to the present.

"*Appropriation*" of institutions, or parts of them, was already permissible for local authorities under Section 95 of the Public Health Acts Amendment Act, 1907, and is now incorporated in, and extended to county councils by, Section 163 of the Local Government Act, 1933. Under these powers lands or buildings acquired by the guardians, and coming into the possession of county and county borough councils, can be removed, with the consent of the Minister, from control by the poor law and administered under the Public Health and other Acts which enable local authorities to provide medical services. This method has been used fairly extensively by local authorities, particularly in connection with the treatment of the tuberculous, the care of the blind and the care of mental defectives. An institution can be "appropriated" only when it is possible to separate it wholly or in part from other buildings still used for poor law purposes. It is obvious that, even if a local authority made a "declaration," institutions would have to be "appropriated," as practically all the available accommodation would exist in institutions formerly provided by boards of guardians. By the 31st March, 1939, fifty-four authorities had appropriated 111 hospitals and there were 137 hospitals provided by local authorities under their public health powers containing 66,805 beds, compared with 59,910 beds provided under their public assistance powers.

A county or county borough council could make a "*declaration*" in terms of Section 5 of the Local Government Act, 1929, to be incorporated in a scheme for discharging the transferred

poor law functions. From the time when such a " declaration " took effect the council would have been debarred from admitting sick persons to any of their institutions under the poor law. As many of the transferred institutions could not be regarded as satisfactory hospitals, and, as there are numbers of chronic cases for whom the stricter discipline of the poor law is preferable, few councils felt justified in making such a " declaration." (An excellent note on " Council Hospitals under the Local Government Act " will be found in the *Supplement to the British Medical Journal*, 27th January, and 3rd and 10th February, 1934.)

The advantages of appropriating institutions for general hospital purposes are obvious. " Patients may be admitted to hospital without recourse to the poor law machinery. The hospital is administered by a medical superintendent instead of being under the control of a master. When the limitations of the poor law are removed, co-operation with the voluntary hospitals in the area is facilitated, and free interchange of patients between the municipal and voluntary hospitals may be effected, to the great advantage of all concerned. Further, should the medical staff of the municipal hospital require strengthening and this be effected by the appointment of consultants who happen to be honorary surgeons or physicians on the staff of the local voluntary hospital, the facilities of the one institution may be made to supplement those of the other, and both may work together as units of one carefully considered hospital scheme. The appropriated hospital becomes an integral part of the public health organisation of the area, is generally administered by the public health committee of the council and is under the general supervision of the medical officer of health, who can readily arrange for the council's specialist medical officers to assist the hospital staff in a consultative capacity." (Annual Report, Chief Medical Officer, Ministry of Health, 1932, p. 162.)

County councils or local authorities are required to consult with representatives of voluntary hospitals as to any hospital accommodation to be provided, other than for persons suffering from infectious disease. Such a requirement should form the basis of co-operation between municipal and voluntary hospitals.

It may be useful here to refer to the power conferred upon local authorities by the P.H.A., 1936, to contribute towards the expense and capital cost of voluntary hospitals. In the first place, Sub-section (3) of Section 181 provides local authorities with a direct power, without entering into any agreement for the reception of patients, to give reasonable subscriptions or donations to voluntary hospitals or institutions, subject to the limit that the expenses so incurred shall not in

any year exceed an amount equal to the product of a penny and a third rate, or such higher rate poundage as the Minister may in any special case from time to time approve. Secondly, Section 271 enables a local authority to enter into an agreement with the authorities of a voluntary hospital for the use, upon such terms as may be agreed, of any suitable buildings, premises, accommodation, equipment or vehicles provided by the hospital. Thus an authority could make an agreement for the use of a complete block or wing of a hospital, or for the use of some special equipment such as X-ray apparatus, or for the use of an ambulance. Moreover, for such a purpose, a local authority could make a capital contribution to enable the buildings, etc., to be provided, and could, with the Minister's consent, raise a loan for the purpose. Thirdly, under the general power to provide hospital accommodation for persons who are sick, given in Sub-sections (1) and (2) of Section 181, local authorities can make arrangements with a voluntary hospital for the reception of patients. Accommodation could be built by the hospital, for example, with the aid of a capital contribution, in respect of which the local authority could, if they desired, raise a loan. Authorities could also make a payment in respect of the maintenance of persons treated in accommodation provided by the voluntary hospitals. Finally, in respect of several of their other public health services, for example, the maternity and child welfare, tuberculosis, and venereal diseases services, local authorities can make similar arrangements for the use of accommodation provided by voluntary hospitals. Apart from contributions made under Sub-section (3) of Section 181, local authorities' arrangements have usually been of the third kind. (Annual Report, Min. of Health, 1937–38, p. 78.)

In county boroughs the absorption of transferred institutional services by the existing public health organisations is generally much easier than in counties where the problem is rendered difficult by the irregular distribution of the population, the number of small mixed institutions and the uneven quality of the nursing arrangements. The rearrangement of institutions and the provision of new accommodation demand a proper classification of patients. The following suggested classification is given in the Annual Report, Chief Medical Officer, Ministry of Health, 1933, p. 198.

1. (*a*) Persons retained unnecessarily in sick wards who could be accommodated in the "House," and who do not need nursing care and attendance.
   (*b*) Healthy infants and children (excluding infants in maternity wards).
   (*c*) Nursing and expectant mothers not requiring medical or nursing care.

2. Persons who by reason of some infirmity need simple attendance and assistance and some medical supervision, but who do not need nursing care.

3. Patients suffering from chronic or incurable complaints for whom little or no benefit can be expected from remedial treatment, but who do require nursing care and medical supervision.

4. Patients suffering from chronic or recurrent affections whose condition may reasonably be expected to improve sufficiently under existing methods of treatment to enable them to go home under domiciliary medical supervision or to be transferred to the " House."

5. Patients suffering from apparently chronic complaints who need better facilities for diagnosis or treatment, and whose condition might thereby be improved or cured.

6. (*a*) Patients suffering from acute and subacute conditions.
   (*b*) Patients recovering from acute and subacute conditions who now need only a limited amount of nursing care and medical supervision.

7. (*a*) Maternity cases, including ante-natal and post-natal.
   (*b*) Infants in maternity wards.

8. Mental patients, including epileptics and post-encephalitics :—
   (*a*) requiring sick nursing ;
   (*b*) not requiring sick nursing, but needing care and supervision ;
   (*c*) capable of accommodation in " House " wards ;
   (*d*) pregnant.

This classification was applied to 2,544 patients in the sick wards of a large county borough, and to 1,984 in a large industrialised county (combined population 2,500,000), with the results as shown in the table on p. 201.

In his Annual Report for 1933 (pp. 193–205) the Chief Medical Officer of the Ministry of Health gave tables showing the available hospital accommodation in England and Wales. There were some 860 municipal hospitals, with 143,000 beds provided by local authorities, and about 1,000 voluntary hospitals with 72,000 beds. These totals included 130 local authorities' hospitals and sanatoria containing nearly 15,000 beds, and 135 voluntary institutions with 9,000 beds for the treatment of tuberculous persons. In addition local authorities had provided 172 hospitals with 139,000 beds for lunacy and mental deficiency, and 954 hospitals with 38,000 beds for infectious diseases (including smallpox). A review of hospital accommodation in 1938 revealed that there were 292,592 beds for all purposes (including 24,370 in institutions under construction or contemplated) in England and Wales, that approximately two-thirds were in institutions owned by local authorities and that of these about three-fifths were in hospitals not

provided in connection with public assistance. There were in the country as a whole 7·14 beds (for all purposes) per 1,000 of the population. The number of admissions to hospitals for the general sick in England in 1938 amounted to 20 per 1,000 of the population.

Hospitals are expensive institutions, and it is important that hospital beds should not be occupied any longer than is necessary.

Group.	A County Borough.		A County.	
	Number.	Per cent.	Number.	Per cent.
1. Fit for "House"	12	0·47	11	0·6
Healthy children	55	2·16	17	0·8
Nursing and expectant mothers			4	0·2
2. Need simple attendance	203	7·17	249	12·6
3. Chronic and incurable	739	29·04	826	41·6
4. Improvable	187	7·35	118	5·9
5. Needing better facilities	31	1·21	60	3·02
6. Acute and subacute	1,222	48·03	168	8·5
7. Maternity	69	2·71	29	1·45
8. Mental, etc. :—				
(*a*) Needing nursing	15	0·58	155	7·8
(*b*) Needing supervision	11	0·43	318	16·03
(*c*) Fit for "House"	—	—	29	1·5

Means by which duration of stay of patients in hospital may be shortened include :—

(*a*) Provision of improved facilities for diagnosis and treatment, and careful periodical reviews of patients.

(*b*) Establishment of "continuation" hospitals, *i.e.* hospitals of simple character, not too far removed from the main institution, but situated in the country where sites are cheaper, to which patients requiring a long period in hospital can be sent.

(*c*) Extension of home district medical and nursing services.

(*d*) Establishment of out-patient departments, which provide special services. Such departments can continue treatment commenced in the wards of a hospital and, in certain cases, may render unnecessary the admission of patients to the wards.

Hospital Development and Future Policy. The pre-war system of hospital administration with its varied resources and well-developed technique was uneconomical and it is fairly generally agreed that a unified hospital service should replace the arrangement of unrelated hospital units which were independent and often wastefully competitive. During the war, therefore, the Emergency Hospital Scheme, designed to meet present conditions, and preparations for a post-war system have gone on side by side though they have tended to converge. Valuable as the Emergency Hospital Scheme has proved, it cannot in itself provide a permanent solution to the hospital

problem, but it has certainly laid the foundations upon which a longer-term hospital policy may be built. In October, 1941, the Minister of Health indicated in the House of Commons the following general principles on which the Government proposed to base the post-war scheme :—

(1) The aim is to ensure, through a comprehensive hospital service, that everyone will receive the treatment appropriate to his need.

(2) The duty of providing such a service wherever it is needed should be laid on the major local authorities, in close co-operation with the voluntary bodies, and to facilitate this the partnership between local authority and voluntary hospitals should be placed on a more regular footing.

(3) The service should be designed by reference to areas substantially larger than those of individual local authorities.

(4) The more highly specialised services will have to be fixed at suitable centres to serve the new, wider areas. Thus, and by proper division of responsibility between hospitals in these areas, wasteful overlapping of function can be reduced.

(5) In so far as local authorities are asked to undertake new burdens, either by providing hospital accommodation themselves or by making contributions to voluntary hospitals so that they may do so, the Exchequer should give financial help. In addition, special State aid, for teaching hospitals, probably in the shape of increased educational grants, must be contemplated.

In shaping the ultimate policy a pooling of the views and experience of interested bodies is essential and many detailed surveys and investigations must be made. Already a survey of hospital services in London and the surrounding area and in a number of other areas, is being carried out in order to provide information for future planning. The voluntary and municipal hospital authorities are collaborating with the medical officers of the areas concerned, and help is being given by the British Hospitals Association, the King Edward's Hospital Fund and the Nuffield Provincial Hospitals Trust. It is hoped to obtain information about the practice, needs and resources of the hospitals in the areas surveyed and the districts they would most conveniently serve.

There has now been established a link between the treatment and rehabilitation aspects of the hospital service on the one hand and the provision for industrial health and welfare and vocational training on the other. Practical effect, on a wartime footing, has been given to the main principles advocated before the war by several commissions of inquiry, including the Inter-Departmental Committee on the Rehabilitation of Persons injured by Accidents. All the resources of the orthopædic and fracture service of the Emergency Hospital Scheme

have been thrown open to all fracture cases occurring among workers in war industry, and a properly related fracture organisation, with graded treatment centres, worked out over appropriate areas, has been established. Vocational training centres for those who have been disabled for their ordinary occupations have been linked to hospitals within the Scheme, and efforts in every direction have been made so to widen the scope of the hospital service that the rehabilitation and the resettlement of the worker has become a more uninterrupted process. (See Comd. 6415, January, 1943).

Similar arrangements have been made in the case of many branches of specialist hospital practice. While the conception of the special unit is not, of course, new, what *is* new is that it should be applied to the larger hospital areas, that individual units should work in co-operation to one design, that over-lapping of services should be avoided and that it should include a system of inter-hospital transfer. The grouping of special treatment centres will no doubt form an important part of post-war hospital policy.

A great deal of experience is being gained through the working of the Emergency Hospital Scheme. (See also Report of the Committee on Post-War Hospital Problems in Scotland, 1943.)

Hospital planning and construction

The following information has been obtained almost wholly from the reports of the Departmental Committee of the Ministry of Health on the Cost of Hospitals and Other Public Buildings, 1937 and 1938.

Acute general hospitals

The size of the hospital must first be determined as well as the number of special departments. It has been suggested that there should be 1·6 beds in voluntary hospitals and 3 in municipal hospitals per 1,000 population. A site must be selected and an endeavour should always be made to provide ample space for future extensions. Whenever possible, all public services should be readily available and the site should lend itself to economical building. Factors other than cost must determine whether the building should be high or low. It has been shown that for ordinary ward construction the cost varies as follows :—

	Relative cost. (Index figure = 100).
Two storeys	107
Three ,,	103
Four ,,	100
Six ,,	102
Eight ,,	107

Every ward unit above ground-floor level should have access to two staircases capable of taking stretchers and, in all but small hospitals, access to two lifts. Main corridors should be 8 feet wide, staircases for stretchers 4 feet 6 inches wide with half-landings 6 feet in depth. There should be an enclosed fire-escape staircase at the end of every projecting wing more than 60 feet in length.

Wards. A ward unit of thirty beds is sufficient for one sister. No ward should contain more than fourteen to sixteen beds, the modern tendency being to subdivide wards. Every unit should contain at least four single-bed wards and two or three four-bed wards. Such subdivision does not increase greatly the cost of ward construction and ensures greater privacy and quiet for the patients. It also permits of better classification of patients and greater elasticity in the use of wards, limits the spread of infection and facilitates ward cleaning and redecoration. The only arguments in favour of large wards are that supervision of patients is easier and therefore a slightly smaller staff may be employed, natural lighting and cross-ventilation are more readily obtained and cost is somewhat reduced.

Corridor planning as shown in Fig. 3A is not favoured in this country on account of the difficulty of supervision and of the fact that natural lighting and ventilation are readily available on only one side of the ward.

The normal arrangement of beds in large wards consists of two rows of beds with the bed heads against opposite walls, each bed head being placed between two windows. More recently some hospitals have adopted the plan of arranging beds parallel to the long axis of the ward. In this arrangement patients do not face the light directly—a matter of some importance if the axis of the ward is east and west. The advantages of this parallel bed system are that the ward can be subdivided by glazed screens into groups of two beds on each side of a central passage or groups of four beds on one side of a lateral passage (see Fig. 3B). Nearly the whole of one side or both sides of the ward can be windows and so patients can be nursed under almost open-air conditions. Verandahs or balconies are therefore unnecessary. Such a ward may be made rather longer and narrower and slightly less high. On the other hand, the cost of supervision may be somewhat higher and increased window surfaces mean a greater heat loss.

The ordinary ward of fourteen to sixteen beds should be 25–26 feet wide (24 feet is the absolute minimum), 11 feet high, and there should be 8 feet between bed centres. In larger wards the height should be 12 feet and in small wards and ancillary rooms 10 feet (if planning permits). Single-bed wards should have a floor space of 10 feet by 11 feet.

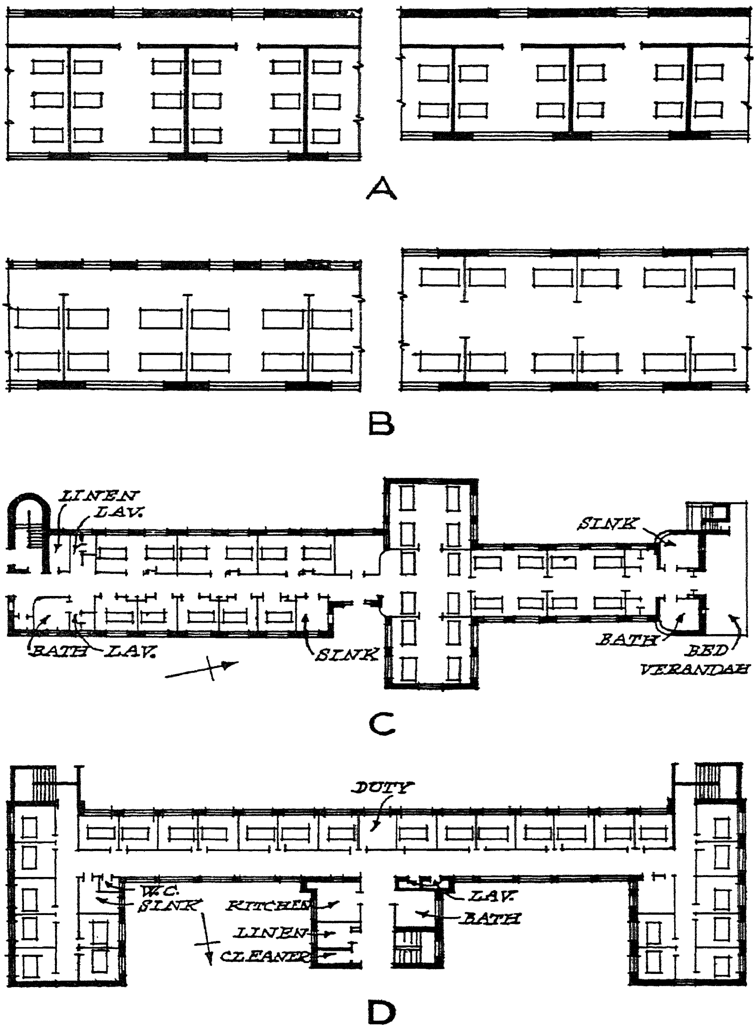


FIG. 3. Hospital Wards.

A. Corridor planning.
B. Longitudinal arrangement of beds.
C. General ward in isolation hospital (L.C.C.).
D. Cubicle isolation ward (L.C.C.).

If the parallel arrangement of beds is adopted the ward need be only 20 feet wide where the passage is lateral and 22 feet where the passage is central. In the former case the glazed screens should be 20 feet apart, in the latter 18 feet. In both cases each patient will have about 100 square feet of floor space.

It is more costly to increase the width than the length of a ward block. An increase in height is the most costly of all.

Ordinarily verandahs or balconies should be provided. These are best placed at the end of a rectangular block and their depth should be about 14 feet.

The ancillary rooms (and their dimensions) required in a ward unit of thirty beds would be :—

1.	Sluice room	100 square feet.
2.	Space for testing . . .	30 ,, ,,
3.	Staff lavatory and w.c. . .	
4.	Cleaners' room . . .	
5.	Bathroom	70 ,, ,,
6.	Patients' lavatory and 2 w.c.'s	
7.	Ward office	70 ,, ,,
8.	Ward kitchen . . .	200 ,, ,,
9.	Duty room	100 ,, ,,
10.	Linen store	70 ,, ,,
11.	General store. . . .	70 ,, ,,
12.	Lighted recess . . .	100 ,, ,,

where the ancillary rooms and one-bed wards are arranged along the two sides of a corridor. The recess may be used as a day room by convalescent patients. The branch corridor leading to the main corridor should be 7 feet wide.

The total area of such a ward unit would be about 4,705 square feet of which slightly less than two-thirds would be occupied by wards.

Other departments. An operating theatre suite should contain in addition to the operating theatre: anæsthetising room, sterilising and hand-washing room, instrument cleaning and sink room, plaster room, linen and dressing-rooms, general store, sister's room, nurses' change room and w.c., surgeon's change room, shower and w.c. The total floor area should be about 1,850 square feet. The height of the theatre and sterilising room should be 12 feet.

An out-patient department containing a casualty department, a department for the continuation treatment of discharged in-patients and a consultative centre should be provided, as well as departments for X-ray, massage and electrical treatment, and a laboratory.

A mortuary block should be placed in some inconspicuous place, selected for easy removal of bodies. It should contain

places in the proportion of 3–4 per cent. of the number of beds and should have a viewing room and a post-mortem room.

The administration block should provide accommodation for :—

1. Committee room and offices.
2. Main kitchen for staff and patients.
3. Dining-room for staff—close to the kitchen. There should be separate dining-rooms for sisters, for staff nurses and probationers, and for female domestic staff. Twelve square feet should be allowed per person of the maximum number expected to be present at any meal. Small tables for four to six persons are advisable.
4. Central stores.
5. Dispensary.
6. Waiting accommodation for patients' friends.
7. Cloakroom and sanitary accommodation.
8. Quarters for the matron and resident medical officers.

The entrance to the hospital should be controlled by a porter's lodge.

Residential accommodation for staff. For an acute general hospital of 400 beds the residential staff would be approximately as follows :—

Medical superintendent .	1
Deputy medical superintendent	1
Other medical officers .	5
Matron	1
Assistant matron . .	1
Home sister and sister tutor	2
Ward and other sisters .	18
Staff nurses	16
Probationers	95
Maids, kitchen and personnel	24

The medical superintendent should have a separate house, and a small house or self-contained flat should be provided for at least one married medical officer.

The nurses' home should contain the training school, common rooms and bedrooms. Maids should be accommodated elsewhere. Every nurse should have a separate bedroom, sisters a bed-sitting room, and administrative sisters a bedroom and a sitting-room. Night staff should have special quarters which should be as free from noise as possible. Bedrooms should be at least 100 square feet, and each should have a fixed lavatory basin. There should be one bathroom and one w.c. to six or eight bedrooms, one shampoo fitting to every fifty nurses, a personal laundry and ironing room and facilities for incineration. Separate sitting-rooms should be provided for sisters, staff

nurses and probationers. A silence room for writing and study is necessary as well as a visitors' room and cloakroom. There should be tea-making facilities on each floor, a small service kitchen and a storeroom for boxes.

The domestic staff may be accommodated in the administration block or, in a larger hospital, in a separate home.

Construction. Brick construction is the most economical for buildings of two to four storeys. Above that, frame and panel construction is cheaper. A flat roof has no advantages over a pitched roof unless it is to be made available for the use of patients. Ward walls should be plastered, hard plaster on the lower 4 feet 6 inches, and painted; floors should be hard wood or thick linoleum laid direct on cement screeding. Floors requiring frequent washing should be paved with granolithic or asphalt. Kitchens, sculleries, w.c.'s, etc., may have tiled floors. Thick rubber makes a good flooring for corridors and special departments. Windows should be cleanable from the inside, should extend to within about 6 inches of the ceiling and about 30 inches of the floor. Doors, where necessary, should be wide enough to allow of the passage of a bed. Metal door frames are cheap and satisfactory.

Forty to fifty gallons of water per head per day (patients and staff) are sufficient. If the supply is from a main, not more than two days' storage is necessary. Each block should be metred. Water of more than 10 degrees hardness should be softened for laundry use and for domestic hot water supply.

Open fires or stoves should be provided only in day rooms and common rooms. For general heating hot water circulation at not more than 160° F. is the most satisfactory. Pipes or coils of pipes form the cheapest method of distributing heat in a ward, but radiators, supported on wall brackets, are most popular. Panel heating (hot water at 120° F.) is coming more and more into use.

Wards should be maintained at	60°–65° F.
Dormitories	45°–65'
Corridors	50°–60'
Day rooms and dining-rooms .	60°–65'
Nurses' bedrooms . . .	50°–60'
Operating theatres . . .	65°–80'

The heating installation should be designed for a difference of 30° F. between outside temperature and temperature of wards, a difference of 25° F. in the case of corridors and bedrooms and of about 50° F. in operating theatres.

Domestic hot water should be delivered at a temperature of from 130° to 140° F.—storage of 5 gallons per head (patients and staff) should be provided.

There should be coal storage for at least three weeks' winter demand.

Natural ventilation by means of windows is usually sufficient except in the operating theatre, X-ray department, kitchen and laundry. The theatre should have a small air-conditioning plant and the other departments should have exhaust fans.

In addition to central ceiling lights and an obscured night light reflecting on to the ceiling, all wards should have a bracket light over each bed and a point for a hand lamp for every two beds. Emergency lighting by gas or from an electrical storage battery should be provided, more particularly for the operating theatre.

Maternity hospital or department

Lying-in accommodation may be provided either in a separate maternity hospital or in a maternity department of a general hospital. Those in favour of the former plan point out that most of the cases in a maternity hospital are "normal," that complications are relatively rare and that emergencies are mainly obstetrical in character. On the other hand, it is argued that a department within a general hospital can be run more economically and that specialist treatment of non-obstetric conditions associated with pregnancy and childbirth is more readily available. The Departmental Committee of the Ministry of Health on Maternal Mortality and Morbidity expressed themselves as being in favour of the latter type of provision.

Small departments should be avoided. It is suggested that a maternity department containing sixty maternity beds, ten ante-natal beds, two to four beds for "potentially septic" cases and four observation beds would be one of convenient size and should prove adequate for the needs of a district having 800–1,000 cases of midwifery a year.

Thirty lying-in beds are enough for one sister. No ward should contain more than eight beds—a four-bed ward is better if planning permits. In a ward unit of thirty beds there should be at least six single-bed wards, each having a floor area of 120 square feet and a height of 9 feet. In the other wards there should be 8 feet between bed centres, each bed should have a floor area of 100 square feet, and the height of the ward should be 10 feet.

A nursery, having a floor space of 25 square feet per cot, should be provided to take all the babies at night.

In a department of sixty maternity beds the labour wards may be concentrated in one section. There should be four first-stage rooms and four delivery rooms together with a sterilising room and a sluice room. First-stage rooms should be 80–100 square feet, and delivery rooms 220 square feet. One of the

delivery rooms may well be made larger and fitted up as an operating theatre.

A reception section is necessary. It should adjoin the ante-natal clinic but have a separate entrance. A small waiting room, two preparation rooms and a bathroom and w.c. should be provided.

Isolation accommodation is important for :—

(*a*) Potentially septic cases, *i.e.* emergency cases admitted in labour without having attended the ante-natal clinic and others in whom delivery has already been attempted. All such cases should be admitted to single-bed wards.

(*b*) Cases of suspected sepsis after delivery, *e.g.* pyrexial cases. It is a good arrangement to have four single-bed wards grouped together for such cases and provided with a duty room and separate sanitary accommodation.

(*c*) Cases of puerperal sepsis. Accommodation for such cases should be provided away from the maternity department.

Every maternity department should have a small hand laundry for infants' napkins and garments.

An ante-natal clinic should be attached and there should be ten ante-natal beds in addition to the sixty lying-in beds, *e.g.* one ward of eight beds and two single-bed wards.

If an extern district is associated with the hospital, accommodation should be provided for district midwives. This would include a room for sterilising and care of equipment. (See also *J. Roy. San. Inst.*, May, 1934, pp. 575–598, "Maternity and Children's Hospitals," Saxon Snell.)

Hospitals or departments for sick children

Here the important consideration is the necessity of preventing spread of infection of various kinds.

A ward unit of thirty beds is suitable for the average children's department of a municipal hospital. Children under two years of age are better nursed in single-bed rooms—of which the unit should contain not less than six. Other wards should have four to six beds. Eighty square feet of space should be provided per patient and there should be 8 feet between bed centres. Wards should have a height of 10 feet. Single-bed wards may have dimensions of 10 feet by 8 feet by 9 feet high. In larger wards observation is made easier by the free use of glazed partitions. Good lighting and open-air treatment are important —hence large windows opening fully or verandahs and balconies should be provided. Balconies must be adequately protected to prevent accidents.

A generous supply of baths is needed. It is well to have a small fixed bath in each single-bed ward for infants. A milk preparation room with facilities for sterilising babies' bottles and a refrigerator should be provided. There should be isolation accommodation apart from the ward units.

Accommodation for the chronic sick

This may be provided either in a special hospital or as part of a general hospital. The latter arrangement is to be preferred. The "chronic sick" differ from the "infirm" who, though not able-bodied, are usually up all day and do not need nursing though they may need some simple assistance from attendants.

Ward units may contain as many as sixty beds. Wards may be large, *e.g.* of twenty to thirty beds, preferably subdivided by glazed partitions. There should be six single-bed wards in each unit.

Wards need not be more than 24 feet wide, there should be 7 feet between bed centres and each bed should have a floor space of 84 square feet. Verandahs and balconies are useful and a day room of 240 square feet per unit is necessary. Doors to bathrooms and w.c.'s should be wide enough to admit of the passage of wheeled chairs.

Residential institutions for pulmonary tuberculosis

There is a tendency for local authorities to concentrate the treatment of all types of pulmonary tuberculosis in one institution rather than to maintain separate small institutions. It may, however, be necessary to provide a certain amount of accommodation for cases of advanced tuberculosis near the patients' homes.

The Joint Tuberculosis Council consider that the optimum size of a hospital sanatorium is about 250 beds and that sufficient ground should be obtained to provide at least one acre for every five patients. The site should be reasonably accessible and public services should be available if at all possible.

A ward unit of thirty to fifty beds may be provided, the size depending on the number of bed-fast patients. No ward should contain more than four to six beds and 15–20 per cent. of the accommodation should be in single-bed wards. Terraces or balconies on to which beds can be wheeled are desirable. In the past, single-storey pavilions were the invariable practice, but recently buildings of two or even more storeys have been erected.

Single-bed wards should have a floor space of 90 square feet. In larger wards 80 square feet per bed are sufficient. Day rooms are usually necessary.

In ward units for ambulant cases there should be one w.c. to eight patients together with a urinal in the case of male patients, one bath to ten patients and one lavatory basin to six patients.

A medical treatment unit containing provision for X-rays, dental treatment, laboratory work, etc., is necessary, and an operating theatre with facilities for major thoracic surgery may be needed, with wards for post-operative cases.

A central dining hall is advisable with accommodation on the basis of 14 square feet per patient for the maximum number estimated to be able to use the dining hall. Provision for occupational therapy and residential quarters for the staff should be included.

There should be heating in all the wards of a sanatorium hospital—in open-air wards the heat should be sufficient to prevent condensation.

Isolation hospitals

No isolation hospital too small to require the services of at least one resident medical officer can be considered an efficient institution. It is commonly said that isolation hospital accommodation should be provided in the proportion of one bed per 1,000 population in addition to special smallpox accommodation, but this may well prove too low a figure in a populous industrial area.

Numerous small blocks are better than a few large ones as a ward block can ordinarily be used only for one disease at a time. One-storey pavilions are usual, but two-storey buildings are quite common. There should be a boundary fence 6 feet 6 inches high all round the site, and ward blocks should be at least 40 feet from the boundary and 40 feet from one another.

Each one-storey ward block should contain one ward unit which should include beds for males and for females. It is usual to have a larger portion of the unit for the accommodation of young children of both sexes and of older female patients. Twelve beds should be the maximum for any ward and four-bed wards are better, especially for scarlet fever patients. Each ward unit should have two single-bed wards.

There should be 12 feet between bed centres, the larger wards should be 24 feet wide and each bed should have 144 square feet of space. A ward of 20 feet by 20 feet is, however, large enough for four beds.

A cubicle block is necessary for cases of doubtful diagnosis or of double infection and for those diseases of which few cases are admitted. In this block six single-bed wards are arranged on each side of a central duty room. The partition between the wards should contain a glass panel 7 feet wide by 4 feet high, the bottom of the panel being about 2 feet 6 inches from the floor. Each room should have a fitted wash basin and the sanitary accommodation should be placed centrally in the block, opposite the duty room but separated from it by a service corridor. The service corridor for the cubicles should preferably be open with a low parapet wall, but in exposed situations it may be necessary to have sliding windows. The various wards can be supervised from the central duty room which

is provided with observation windows. A cruciform type of cubicle block may be employed, each of the four units containing six single-bed wards, a central duty room being placed at the point of intersection of the units. A L.C.C. isolation block of recent design contains twenty-eight rooms on each floor (see Fig. 3D, p. 205).

For diseases of low infectivity the "*bed isolation*" or "*barrier*" system has at times been advocated. Cases suffering from different infectious diseases, *e.g.* typhoid fever, mumps, diphtheria, rubella and possibly whooping-cough, are all treated in the same ward, but each case has its own utensils and appliances and rigid precautions are taken to prevent cross-infection. Success has not, however, always attended this practice.

It may be advisable to provide independent heating of individual blocks in an isolation hospital as some of the blocks will be occupied only intermittently.

An isolation hospital should be designed for the specialised treatment of cases of infectious disease. It must therefore have adequate equipment, including a Drinker apparatus or steel lung and perhaps a Bragg Paul apparatus which are needed for a variety of conditions. An operating theatre is necessary and sterilisers should be provided in wards for the sterilisation of crockery, bed-pans, etc. (*Public Health*, March, 1938, pp. 169–178, Brincker.)

Smallpox hospitals require special consideration. As smallpox patients bear removal very well, there is no need to select a site in close proximity to a populous district. The Ministry of Health requirements are :—

1. The site must not have within a quarter of a mile of it a hospital, workhouse or asylum or any similar institution or a population of 200 persons.

2. The site must not have within half a mile of it a population of 600 persons, either in institutions or in dwelling houses.

3. A smallpox hospital must not be used at one and the same time for the reception of cases of smallpox and of persons suffering from any other disease.

It is of interest that accommodation for cases of smallpox has recently been provided as an annexe to, though completely separated from, the isolation hospital of the City of Bristol.

It is not uncommon to find smallpox hospitals used for the treatment of patients suffering from tuberculosis or cases convalescent after scarlet fever. Arrangements should provide for the immediate evacuation of these patients on the occurrence of smallpox in the district.

No hospital for infectious disease is likely to be able to accommodate all cases occurring during a serious epidemic, and it may be necessary to secure hospital provision of a

temporary character. In this connection tents, though not to be recommended, are sometimes used. A bell-tent has a capacity of some 500 cubic feet and can accommodate one patient, a regulation hospital marquee, of some 3,300 cubic feet, three cases.

Mental hospitals

It has been recommended that such a hospital should accommodate not more than 1,000 patients and that it should be built on the villa system. The site should be one of at least 150 acres.

Provision should be made for separate ward units for the following groups :—

	Per cent.
Recent and recovering	10
Sick	7
Able-bodied, trustworthy and working, on parole	20
Disturbed and excited	16
Senile and infirm	7
Epileptic	10
Undefined types—quiet, able-bodied, not on parole	30

The size of the ward unit varies. None should contain more than fifty beds and in certain cases the number of beds should be as small as from fifteen to twenty. No dormitory should have more than thirty beds—four to sixteen for restless patients. There should be 5 feet between bed centres and at least 50 square feet of floor space in the case of healthy and active patients. Wards should be at least 20 feet wide. Single-bed wards should form not more than one-fifth of the total accommodation and there should be one or more in each ward unit.

Wash basins are needed in the proportion of 1 to 6 patients, w.c.'s 1 to 8 by day and 1 to 30 by night, baths 1 to 20.

Separate accommodation should be provided for those patients who are suffering from physical illness—about 7 per cent. of the total beds. Some six to eight beds are necessary for tuberculous cases. Provision must also be made for other infectious cases including carriers of typhoid or dysentery bacilli.

Public assistance institutions

These should provide accommodation for :—

1. Healthy aged—best in cottage homes.
2. Infirm persons, who require assistance from the staff and have to spend occasional days in bed.
3. Able-bodied.

4. Expectant and nursing mothers.
5. Healthy children under three years—in nurseries.

Cost of maintenance

Save in the case of patients under treatment for infectious disease, local authorities are required to recover from patients or from those legally liable to maintain them the whole or part of their maintenance costs in hospital. The assessment of what a patient can afford to pay is usually made by an almoner who has certain rules for her guidance. It is customary to determine first the gross income of the person liable and to deduct from this such special forms of income as wounds or disability pension, workmen's compensation weekly payments, national health insurance benefit, and certain outgoings such as fares to and from place of employment, insurance premiums, rent and rates. An allowance is made also for the general needs of the family. The balance is the assessable income. In the case of a contributor to the Hospital Saving Association, no such assessment is usually made as the Association pays the local authority fixed weekly amounts for the first, say, ten weeks' treatment in hospital for contributors and their dependants. (See Min. of Health Memo. 266/T., 1943, for special arrangements in connection with financial assistance for persons suffering from pulmonary tuberculosis.)

Under the Voluntary Hospitals (Paying Patients) Act, 1936, a voluntary hospital may apply to the Charity Commissioners for an order authorising the hospital to provide accommodation for paying patients. The scale of charges must be specified in the order and includes the cost of treatment provided by the *resident* staff of the hospital. (*B.M.J. Supplements,* 17th and 24th December, 1938.)

The cost of maintenance per patient per week depends on the following factors :—

(*a*) Percentage occupation of available beds. This is affected by the incidence of disease, any constructional work being done, redecoration, wards in quarantine, etc. It must be remembered that a local authority's hospital must admit all cases falling within approved categories. It cannot select cases as can voluntary hospitals.

(*b*) Salaries and wages of staff—these account for about 50 per cent. of the weekly cost.

(*c*) Engineering and works services amount to about 18 per cent.

(*d*) Patients' food, cooking and service cost under 11 per cent., drugs and dressings about 3·6 per cent.

The inclusive cost per occupied bed per week in the L.C.C. hospitals during 1937–38 was as follows :—

	£	s.	d.
General, acute	4	2	2
General, chronic and other cases . .	2	11	1
General, convalescent	2	16	3
Tuberculosis	4	3	0
Children's	3	8	7
Children's, convalescent	2	14	7

The cost in acute general hospitals varied according to the size of the institution from £5 7*s*. 10*d*. to £3 10*s*. 1*d*.

A committee on hospital equipment, established in connection with the Public Health Congress, issued a report in 1934 and arrived at the following conclusions :—

1. Some 30 per cent. of the total maintenance costs of hospitals is incurred in respect of goods which can readily be standardised without affecting the efficient working of the institutions or interfering in any way with the requirements of the professional staffs.

2. Some of the advantages of such standardisation are :—

(*a*) Economy—due to reduction in the number of types and consequent lowering of manufacturing costs ;

(*b*) improvement of design, rendering the articles more generally suitable for the purpose for which they are required ;

(*c*) greater ease and efficiency in the examination of deliveries.

3. The full benefits of standardisation can be secured only under a system of bulk purchase which provides for expert buying, the uniform testing of supplies and a constant review of markets and developments.

Capital expenditure by county boroughs and county councils in respect of improvements and extensions to hospital accommodation and ancillary purposes during the year ended 31st March, 1939, amounted to £1,913,310.

Much useful information on hospital costs appears annually in the " Statistical Summary of King Edward's Hospital Fund for London " and in the Annual Report of the L.C.C., Vol. IV. (Part II.), Public Health, Hospital Finance.

DISINFECTANTS AND DISINFECTION

Disinfectants. A disinfectant is a germicide ; an antiseptic merely inhibits growth and does not necessarily kill. A deodorant may remove smell either by altering the chemical composition of the substance with which it is in contact or by substituting its own odour for one that is less desirable. It is not necessarily a disinfectant or an antiseptic. All processes which sterilise also disinfect, but all disinfectants do not sterilise owing to the great resistance of spores. Most diseases are produced by non-sporing organisms and, therefore, sterilisation is rarely necessary except in the case of anthrax, tetanus, etc.

The germicidal efficiency of a disinfectant may be compared with phenol by the Rideal-Walker method and stated in terms of its carbolic coefficient. If a disinfectant has a carbolic coefficient of 10 it means that it will kill the *Bact. typhosum* under laboratory conditions in the same time as a certain strength of carbolic, but in a solution ten times more dilute. The Rideal-Walker test is really only of value in comparing a disinfectant with carbolic as regards its action on the *Bact. typhosum* under special laboratory conditions.

Most disinfectants penetrate slowly, and, as the bacteria are often embedded in various substances, stronger solutions of disinfectant are necessary than laboratory tests would indicate. Organic matter interferes with the efficiency of most disinfectants as it is attacked by oxidising agents and coagulated by metallic salts. Very few disinfectants act instantly, even in strong solutions and under favourable conditions, and the time factor is therefore of great importance. As a general rule disinfecting properties are increased in warm solutions.

A satisfactory disinfectant should not be poisonous to higher animals, should not corrode metals or rot fabrics, should not stain or bleach, should not have an unpleasant smell, and should be reasonably cheap and readily miscible with water. It should not deposit from solution or suspension, should be reasonably stable, should act both in alkaline and acid media, should not be greatly influenced by the presence of organic matter, and should possess fair power of penetration.

Coal tar disinfectants. These are made by the distillation of coal tar, and consist of thick fluids containing tar acids such as phenol, cresol and other phenoloid bodies. Those which form solutions when mixed with water are essentially sodium and potassium salts of the various phenols, while the emulsions are composed of phenolic acids together with soap, oils, resins, or gelatine. Many of the commercial coal tar disinfectants are practically free from phenol, are consequently relatively non-poisonous, and are more efficient as germicidal agents than phenol itself. Emulsions are more germicidal than solutions on account of the "Brownian movement" they exhibit when mixed with water, and the bombardment which takes place between the emulsified particles and the organisms results in a quicker and more effective appropriation of the germicide. Heat accelerates this vibratory velocity.

Crude carbolic is a mixture of phenol, ortho-, meta- and para-cresols and inert tar oils. A dilution of 1 in 20 may be used for disinfecting clothing and bedding. This does not harm fabrics or affect colours or metals, but is apt to leave a stain, due to the presence of tar oils and other impurities. Its carbolic coefficient is greater than pure phenol on account of the cresols it contains, and as a rule falls between 2 and 3.

Its effect on the organism is probably toxic. It does not coagulate albumen.

Pure phenol (C_6H_5OH) is not so efficient as crude carbolic, but it does not stain. A 1 in 100 solution at 37° C. will destroy organisms, other than spores, in twenty minutes. Phenol is the crystallisable portion of crude carbolic acid, and cresol or cresylic acid the liquid portion. Carbolic acid powders consist mainly of cresylate and carbolate of lime which possess little or no germicidal power. Lime is an unsuitable base as it combines with carbolic acid; and gypsum, infusorial earth, and non-alkaline substances are to be preferred as these absorb the acid without combining with it.

Cresol, used as liquor cresoli saponatus, is an excellent coal tar disinfectant. It is derived from toluene just as phenol is derived from benzene, and together with phenol is present in creosote. It is used as a fine emulsion, but is thrown out of emulsion by a saline solution such as sea-water. If, however, cresol is mixed first with five to ten times its bulk of fresh water, sea-water can be subsequently added to the required amount. (For strength of solutions see p. 219.)

Izal and cyllin have a carbolic coefficient of about 20. They are both used for general purposes in a dilution of 0·5 per cent. Izal, although a product of coal, does not contain carbolic acid. It is obtained as a pale yellow-coloured oil which is made into an emulsion with gelatine and water.

Lysol is a saponaceous fluid, contains about 50–60 per cent. of cresol, and has a carbolic coefficient of between 5 and 10. It is commonly used in 1 per cent. solution.

Other disinfectants. Perchloride of mercury ($HgCl_2$) is a very powerful disinfectant. A 1 in 1,000 solution will kill organisms, other than spores, in thirty minutes, while 1 in 500 will destroy spores in one hour. It is very poisonous, corrodes metals and forms insoluble compounds with albuminous matter. It is therefore not suitable for the disinfection of fæces and sputum as the insoluble albuminate coat hinders penetration. The presence of sulphides renders it inactive. The salt is not readily soluble in water, but its solubility is increased by the addition of hydrochloric acid, which at the same time reduces the amount of insoluble albuminate formed but increases the corrosive action on metals. A solution of perchloride of mercury is indistinguishable from ordinary water, and it is therefore coloured with aniline blue to prevent accidents. The Ministry of Health recommends the following formula:—mercury perchloride 0·5 oz., HCl 1 oz., aniline blue 5 grains, water 3 gallons. This represents a 1 in 960 solution.

Formaldehyde (HCHO) is a disinfectant which may be used either in gaseous form or in solution as formalin (40 per cent. solution). It is poisonous to human beings. On exposure to

cold. formaldehyde tends to precipitate out of solution as paraformaldehyde. The presence of organic matter does not impair to any material extent its disinfecting action. Gaseous formaldehyde may be liberated for disinfecting purposes either by heating paraform tablets (25–30 per 1,000 cubic feet of space) or by mixing 5 oz. of potassium permanganate and 10 oz. of formalin or 2 lb. of chloride of lime and 2 pints of formalin per 1,000 cubic feet. The mixture should be made in an iron vessel at a point in the room well above floor level. A temperature of 70° F. and a relative humidity of 70 per cent. should be maintained. (See p. 221.)

Potassium permanganate ($K_2Mn_2O_8$) has a very limited application as it is reduced and rendered inert by organic matter. It is, however, a powerful oxidising agent as each molecule is capable of parting with 5 atoms of oxygen. It stains textiles, but the stains may be removed with oxalic acid or lemon juice. Eating and drinking utensils can be sterilised if placed for five minutes in a 1 in 1,000 solution of permanganate.

Sodium hypochlorite solution may be obtained by the electrolysis of salt solutions such as sea-water, and is often employed on ships for disinfecting purposes. The apparatus used is an electrolytic cell in a wooden tank with a reversing switch and a direct current of 100–110 volts. The tank is filled with cold sea-water and the current switched on for five minutes. To make a solution of 1 part of chlorine in 15,000 parts of water twice as much sea-water is added. This is suitable for floors, but for latrines a 1 in 3,000 solution is required, and for disinfecting purposes in wards a 1 in 1,000. The solution is unstable and corrodes metals.

Lime (CaO) is one of the best and cheapest disinfecting substances, and can be used either alone or as chlorinated lime. It is a very caustic substance and requires only the addition of water for germicidal purposes. A 1 per cent. solution kills organisms, other than spores, in a few hours. (See excess lime treatment of water, p. 455.)

Chlorinated lime (bleaching powder) is unstable and deteriorates on keeping. It should be kept in airtight containers. It not only bleaches but is destructive to fabrics. When used in 0·5 to 1 per cent. solution it will kill most bacteria in from one to five minutes.

Disinfectants and Insecticides

The following strengths are suggested :—

1. *Cresol emulsion* (1 per cent.) :—

Saponified cresol (liq. cres. sap. fort.) .	1½ oz.
Water to	1 gallon

When disinfection of textiles must be effected in thirty minutes the amount of cresol must be increased to 4 oz. (2½ per cent.).

When liq. cres. sap. is required to be used with sea or brackish water, it should be emulsified with five to ten times its bulk of fresh water, and then added to the required amount of sea-water.

Corrosive sublimate solution (0·1 per cent.) :—

Corrosive sublimate (mercuric chloride)	70 grs.
Hydrochloric acid . . .	3 drs.
Water to	1 gallon

The solution should be tinted with a sufficiency of commercial aniline blue (about 1 grain to the gallon) to give it a distinctive colour.

3. *Formaldehyde solution* :—

Formaldehyde solution (40 per cent. formalin)	8 oz.
Water to	1 gallon

4. *Cresol and soft soap emulsion for fleas* :—

Cresol.	5 parts
Soft soap	20 ,,
Water	75 ,,

The cresol and soft soap are added to the *hot* water with continuous stirring. For use make a 5 per cent. solution with water.

5. *Paraffin and soft soap emulsion for fleas* :—

Hard soap (or soft soap 1½ lb.) . .	1 lb.
Paraffin oil	4 gallons
Hot water	1 gallon

Dissolve the soap in the hot water; add very gradually the paraffin oil, with continuous stirring. For use make a 5 per cent. solution with water.

(From "Army Medical Regulations," Appendix 4, 1938.)

Disinfection

"Current" disinfection means the usual disinfection carried out in the sick-room; "terminal" disinfection refers to the treatment of the room after the patient has been removed to hospital or recovered from the disease.

Current disinfection. Sputum and nasal discharges are best collected in gauze and burnt. If the amount of sputum is considerable a flask containing a disinfectant, such as 5 per cent. solution of carbolic, should be used. In individual cases

the contents of the flask may be burnt, but in hospitals some form of steam autoclave is required. Excretal matter should be received into a bed pan containing cresol or 5 per cent. carbolic acid. More should be added after use, the contents should be well mixed and left to stand for two hours before being emptied down a drain or buried in the ground. If no other disinfectant is available hot water may be added to the stool, followed by about a quarter of the total bulk of quick lime or a 3 to 5 per cent. solution of chlorinated lime in excess of the mass to be disinfected. In neither case should the mixture be discharged down a drain owing to the risk of blockage. If no central disinfecting station exists, bed linen, blankets and similar articles should be soaked in cresol or in a 5 per cent. solution of carbolic acid for twelve hours before being washed. Linen soiled with excreta should not be boiled without preliminary soaking or a permanent stain will result. Other articles which cannot be soaked in disinfectant or destroyed should be left in the room during disinfection and afterwards exposed to the air and sun for a whole day. All remains of food should be burnt, and eating utensils sterilised. A bowl containing a solution of 1 in 1,000 perchloride of mercury or some coal tar disinfectant of equivalent strength should be available for the attendant's hands, and thermometers should be kept in a disinfectant solution such as 5 per cent. carbolic acid.

Terminal disinfection. Articles of little value should be burnt, and mattresses, bedding, etc., removed for steam disinfection. Furniture should be drawn away from the walls, drawers and cupboards opened and their contents spread about the room. The only satisfactory method of disinfecting a room is by means of a liquid spray. Formalin, 8 oz. to the gallon of water, may be applied by a handworked pump such as the Mackenzie sprayer—1 gallon for every 400 square feet of surface. If 5 per cent. of glycerine is added to the solution it confers viscosity and delays drying. A 1 per cent. solution of liq. cres. sap. or other disinfectant of equal strength may also be used. Walls should be sprayed from below upwards, working horizontally, and the room kept closed for six hours. Windows and doors should then be opened and all surfaces scrubbed with hot water and soap. In the case of smallpox or where wallpaper is cracked or in bad repair, all layers should be stripped and the walls washed with hot lime before they are re-papered. The addition of 2 oz of bleaching powder to a gallon of lime wash makes a useful mixture. A room sprayed with formalin in the morning may be occupied again the same night. In some cases a family may have to be accommodated in a reception house while the home is being disinfected.

Steam disinfection. All bedding and clothing should be

sent to the disinfecting station in a special van. Blankets, boots, furs, books and similar articles are disinfected by other means (see p. 223). Linen, etc., soiled with discharges should never be treated directly with steam, as the stains will remain permanently fixed.

Disinfection may be carried out either by steam under pressure or by current steam. The Washington-Lyon machine (Manlove, Alliot and Co.) is a good example of a high-pressure apparatus. It consists of a hollow-jacketed metal chamber with a separate boiler. The articles are placed in a large wire cradle which can be run out of the chamber on rails. Hooks on which smaller articles may be hung are provided. At each end is a heavy door fastened by clamps. When the chamber is filled the doors are closed and steam at a temperature of 240°–250° F., *i.e.* at about 20 lb. pressure, is admitted to the hollow jacket. This heats the inner surface of the chamber and prevents condensation. When the walls are sufficiently heated a vacuum is produced in the inner chamber and maintained for some minutes; steam under pressure is then admitted for about twenty minutes, after which a vacuum is again made; the whole process occupies about an hour. Clothing is dried by drawing a current of hot air through the disinfector. A thermograph shows the temperatures reached during disinfection. In current steam disinfectors the lower part of the jacket forms the boiler and in some cases, *e.g.* the Thresh, a solution of calcium chloride is used in the boiler to raise the temperature of the steam to about 215° F. When steam comes into contact with an object below 212° F. it condenses and parts with 537 calories of latent heat. A thousand times as much heat is required to convert 1 lb. of water at 212° F. into steam at 212° F. as to raise 1 lb. of water from 211° F. to 212° F. Conversely, a similar amount of heat is liberated when 1 lb. of steam at 212° F. is converted into water at 212° F. Lastly, when steam condenses it occupies less than $\frac{1}{1600}$ of its volume, and thus creates a partial vacuum which facilitates penetration.

The efficiency of any machine may be tested by placing in the centre of articles to be disinfected sterilised gauze smeared with cultures of various organisms which after disinfection should show no growth in suitable media. Maximum and minimum thermometers may be placed in different parts of the chamber, or an electric apparatus may be used which makes contact and indicates when a given temperature is reached.

Glass tubes filled with a chemical and some aniline dye may also be used in a similar way. The chemical is chosen for its property to melt at the desired temperature. Thus naphthalene with a melting point of 80° C. may be combined with rosaniline, exalgin with a melting point of 100° C. with brilliant green,

and sulphonal with a melting point of 124° C. with scarlet red. When the desired temperature is reached the chemical melts and takes the colour of the dye.

Articles liable to be injured by steam, such as woollen articles, leather goods, books, etc., may be hung on wires in a zinc-lined chamber and exposed to 5 per cent. formaldehyde. The various patterns of steam disinfectors may be adapted for use with formaldehyde. The temperature of the chamber is first raised by blowing steam into the jacket, a partial vacuum is produced in the inner chamber, and finally formaldehyde and hot air are admitted. It is better to disinfect blankets in this way or to soak them in a warm disinfectant solution, as they deteriorate after repeated steam disinfection.

Balmain has shown that hæmolytic streptococci may be recovered from books that have been experimentally infected, but infection, save in the case of smallpox and possibly of typhoid fever, is rarely spread by means of books, bedding and similar articles.

The disinfecting station. The essential principle is that there should be an " infected " side and a " disinfected " side, with no intercommunication save through the disinfecting machine. The machine should be built into the dividing wall between the two compartments, and a small panel of glass should be provided in the same wall for observation purposes. Each set of infected articles is packed in a large canvas bag and brought to the station in a zinc-lined van. They are then passed through the disinfector and are taken out on the " disinfected " side after disinfection. Washable articles are then laundered if a laundry is attached, and finally all disinfected articles are returned to their owners. A different van with a separate garage or stable should be used for this purpose. The structure of the buildings should be such that they can be readily and thoroughly cleansed with a hose. Storerooms for infected and for disinfected articles are advisable. In some disinfecting stations separate bathrooms are provided for the staff on both the infected and the disinfected sides.

A cleansing station is often attached where verminous persons, especially school children, may be cleansed while their clothing is being disinfected. This consists of a waiting hall fitted with benches and adjoining sanitary accommodation for both sexes ; a special head-cleansing room with hot and cold sprays and electric driers ; bathrooms with separate dressing-rooms, where the patients wait while their clothes are being disinfected. The persons to be cleansed should enter by one door and those who have been treated should leave by another to avoid contact.

Reception houses are sometimes associated with disinfecting stations. They may be used in exceptional circumstances for

the housing of contacts of such diseases as smallpox, typhus, plague or cholera. No attempt need be made to secure complete quarantine of such persons, but their removal to a well-regulated establishment affords opportunity for proper cleansing and skilled observation. Sometimes it is possible to convert an old house into suitable quarters; the site must be fairly central so that workpeople housed in the building may not be at too great a distance from their work. Quarters for more than one family or more than one disease should be provided. A caretaker will be required, and a nurse or health visitor should be in attendance when the reception house is occupied.

Value of disinfection. If current disinfection is carefully practised throughout the course of the disease, terminal disinfection would appear to be unnecessary in the case of such diseases as measles, scarlet fever and diphtheria. The free use of soap and water, followed by thorough ventilation, should suffice in diseases of this nature. Most organisms do not retain their virulence for long when separated from their host, and human beings and not inanimate objects are the real source of infection. Recent work, however, has shown that hæmolytic streptococci and diphtheria bacilli remain viable for a considerable time in dust and fluff from blankets, etc., but, in spite of this, as it is highly improbable that infection will be conveyed in this way, current disinfection, if strictly carried out, should suffice.

In a number of large towns in this country, generally throughout the United States, and in certain European countries, terminal disinfection has been discontinued without any increase in the number of secondary cases.

Disinfection of sandpits in public parks and nursery schools. Sandpits may be disinfected with bleaching powder in the proportion of 1 lb. to 20 tons of sand. The surface of the pit is moistened thoroughly with water, sprinkled with a mixture of bleaching powder and water, and the top layer of sand turned over and more bleaching powder solution applied. The pit is then sprayed with water and left covered for at least three hours. In nursery schools pits measuring 7½ feet square by 18 inches deep require 2½ oz. of bleaching powder, which is first made into a creamy paste with water and stirred into the water to be used for sprinkling. Sand trays in classrooms are treated in a similar way once a month.

Destruction of bed bugs. The clearance of slum areas and the rehousing of the inhabitants have made the disinfestation of dwelling-houses and their contents a matter of importance to local authorities, if infestation of the new homes by bed bugs is to be prevented. It is estimated that four million people in Greater London alone are troubled by bed bugs which are

almost as much in evidence in many new housing estates as elsewhere. A distinction should be made between *minor infestations* which may be successfully dealt with by the householder himself by general cleanliness and by spraying with contact insecticides such as kerosene containing pyrethrum or derris (not ortho-dichlorbenzene, nitrobenzene or carbon tetrachloride), and *major infestations*, where help should be obtained from the local authority. Some authorities stress the importance of scrubbing and cleaning with soap and water, usually under supervision. Picture rails, other woodwork and wallpaper are removed, holes and cracks in woodwork flamed with a blow-lamp, walls and ceilings distempered and repaired, and woodwork replaced. A reduction in infestation will follow upon these methods, but persistence is essential in order to destroy bugs hatched from unharmed eggs. An attempt to prevent the possible infestation of houses is being made in some places by abolishing skirting boards, picture rails, etc. Reinfestation, notably through the agency of second-hand furniture, must be guarded against.

A really satisfactory disinfesting agent must be harmless to human beings, lethal to all stages of bed bug and egg, cheap and easily applied, harmless to fittings, paintwork, furniture, etc., and readily removed by ventilation. A number of fumigants, of which the most common are sulphur dioxide, ethylene oxide mixed with carbon dioxide, and hydrogen cyanide, have been used with varying success. Of these sulphur dioxide is not lethal to eggs and larvæ, and it also tarnishes metals and damages fabrics. Ethylene oxide in high concentrations is dangerous in the presence of naked lights and is costly. Hydrogen cyanide, while not possessing any of these disadvantages, requires the greatest care in handling on account of its markedly lethal effect on man. The use of ortho-dichlorbenzene has been discontinued on account of its toxic properties.

Fumigation by hydrogen cyanide should be done only by experienced persons. Many simple yet important precautions have to be taken, *e.g.* single rooms should never be done unless the whole building can be vacated ; bedding, because it absorbs hydrogen cyanide and may give it out later with fatal results, is best treated by steam.

A transportable steel fumigation chamber is used in some towns for the disinfestation of furniture. It is generally used when tenants are moving from slums to better houses. Fittings include gastight doors, heaters, vaporisers and exhaust system. This " container," when loaded with furniture, is carried on a trailer drawn by a tractor to the fumigation station ; heaters, vaporisers and exhaust are connected with their respective units, liquid HCN is poured into the vaporiser, which is then closed.

When fumigation is complete, vaporiser and exhaust valves are opened, a powerful fan draws out the gas through ducts up a tall chimney, air entering through the vaporiser and circulating among the furniture. A test is then made for the presence of gas in the van with benzidine copper acetate. Should traces of gas still remain, the fan is again set in operation. The furniture van is usually at the disinfecting station for about six hours (two hours' exposure to HCN, two hours' mechanical ventilation and two hours' natural ventilation).

Furniture is exposed to a concentration of 1·07 per cent. by volume of HCN for two hours at a temperature of 25° C. This is equivalent to 13·3 oz. of HCN per 1,000 cubic feet. For a standard van of 600 cubic feet $\frac{1}{2}$ lb. of HCN will give a concentration of 13·3 oz. per 1,000 cubic feet. Special precautions are taken to see that all soft goods are free from gas before being returned to the owner, and instructions are left in the house that windows must be opened and fires kept alight. The whole process can be carried out easily in one day. If bedding is fumigated, it should not be used for twenty-four hours afterwards. It is advisable when collecting the furniture to place the bedding in the back of the van so that on arrival at the disinfecting station it can be easily removed and passed through the steam disinfector. When the furniture and bedding of more than one house are collected in the same van the articles are identified by the attachment of coloured labels.

When empty houses in a clearance area prior to demolition are disinfested, care must be taken to make each house as gas-tight as possible by sealing up from the outside. An area round the house should be roped off and watchmen should be posted to see that no unauthorised person is allowed to approach. Operatives should wear gas masks and opening up must be done with special caution. Six hours' treatment with at least 2 per cent. of gas should prove effective. This higher concentration will allow for leakage.

In the case of an occupied house, arrangements must be made for the tenant to vacate the premises for at least one day, but twenty-four hours is the minimum period which should be allowed for ventilation of premises after fumigation. Adjacent houses in a terrace should also be vacated. Fumigation should last from three to four hours, after which windows should be opened, fires lighted, and all upholstered articles and soft goods beaten, if possible in the open air. The atmosphere in each room should be tested with benzidine copper acetate solution for freedom from gas. Benzidine copper acetate is a mixture of equal parts of solutions of pure copper acetate and benzidine acetate in distilled water. A test paper is dipped into the solution and exposed to the air for ten seconds. A blue colour, in all air spaces, indicating a concentration of

0·01 oz. per 1,000 cubic feet or less gives a margin of safety. Old damp houses retain the gas for long periods, and unless they can be vacated for several days should not be fumigated with HCN.

Fumigation by heavy naphtha. Heavy coal tar naphtha has bug-destroying properties for all practical purposes equal to those of hydrogen cyanide, and is non-toxic to man. The method of using it, however, is far too complicated to make it of any real value. (Min. of Health Report No. 72, 1934, and Memo. 180/Med., 1934; Brit. Museum Natural History, Economic Series No. 5, 1937; M.R.C. Special Report No. 245, 1942.)

The Hydrogen Cyanide (Fumigation) Act, 1937, gives the Secretary of State power to make regulations with respect to the fumigation of premises and articles (including any ship, vehicle or aircraft) with hydrogen cyanide. Such regulations do not apply to the fumigation of rabbit warrens or to fumigation carried out in the open air.

The Act also requires that the persons by whom fumigation is carried out must notify the Secretary of State of any accident which involves loss of life or personal injury.

The Hydrogen Cyanide (Fumigation of Buildings) Regulations, 1938, define (*a*) the "fumigation area" as the building, or part of the building, undergoing fumigation, and (*b*) the "risk area" as including those parts of any building which are both less than 40 feet measured horizontally from the nearest boundary of the fumigation area and not separated entirely from it by any space open to the air of not less than 10 feet in width. The "undertaker" is any person who, under contract or otherwise, undertakes the carrying out of a fumigation with hydrogen cyanide.

1. Forty-eight hours' notice of any forthcoming fumigation must be sent by the undertaker to the officer in charge of the police station nearest the fumigation area and to the M.O.H. The fumigation staff must consist of at least two persons, one of whom must be in possession of the keys of the premises and must remain in attendance till the risk area and the fumigation area have been certified to be free from danger.

2. No fumigant may be liberated till—

(*a*) all persons other than the fumigating staff have left the areas;

(*b*) all liquids and foodstuffs liable to absorb the fumigant have been removed from the fumigation area;

(*c*) all fires and naked lights in the fumigation area have been extinguished;

(*d*) every door or other means of access to the fumigation area or the risk area has been securely fastened and possession has been taken of the keys;

(*e*) notices containing, in block letters not less than 2 inches

in height, the words "DANGER: POISON GAS: DO NOT ENTER" have been placed where they may readily be seen by any person approaching the areas;

(*f*) all practicable steps have been taken to seal all openings, cracks or crevices so as to prevent the escape of the fumigant from the fumigation area; and

(*g*) the appropriate entries have been made in the prescribed register.

3. The fumigant must not be so applied as to exceed a concentration of 4 parts in 100 in any part of the building.

4. The fumigating staff must carry ready for immediate use an efficient mask and electric torch and first aid appliances must be constantly available.

5. No person other than a member of the fumigating staff may enter the fumigation area after fumigation till (*a*) the area has been properly ventilated (the period required for a dwelling-house is at least twenty-four hours) and the area has been found to be free from danger by tests (a certificate to this effect must be sent to the M.O.H.), and (*b*) all residues of fumigating substances have been removed and all water in cisterns, tanks, etc., has been run off.

6. The risk area and any buildings adjoining it must be kept under observation while there is a high concentration of fumigant in the fumigation area, and all bedding, blankets, pillows, clothing, cushions and upholstered articles likely to absorb the fumigant must be treated till free from danger as established by tests, and for this purpose must be removed from the fumigation area if need be. At least one member of the fumigating staff in possession of all keys must remain in attendance until the areas concerned have been certified free from danger.

Fumigation of ships has for its main object the destruction of rats. Sulphur dioxide may be used for this purpose in concentrations of 2 per cent., either as 3 lb. of roll sulphur or 4 lb. of liquid SO_2 per 1,000 cubic feet. In the Clayton system, which has never been extensively used in this country, sulphur is burned in a furnace and the gas propelled by fans into the ship. Hydrogen cyanide is, however, becoming much more generally used. In skilled hands it is comparatively safe and has a decided advantage over SO_2 as it does not tarnish metals or damage articles. There is also no risk of fire. Hydrogen cyanide is a colourless gas, has a density of 0·94 and diffuses slowly. The small amounts which may be absorbed by foodstuffs, particularly when moist, are rapidly evolved or oxidised on exposure to air or during cooking. As a rule the nutritive value of food is not altered in any way, though fresh fruits may be rendered unsaleable after treatment by high concentrations of HCN or after long exposure to

lower concentrations. Monier-Williams has suggested 20 parts of HCN per million as the permissible limit in foodstuffs. (Ministry of Health Report, No. 60, 1930.) Hydrogen cyanide may be generated in any of the following ways :—(*a*) Liquid HCN may be pumped from cylinders or thrown in glass ampoules into the hold. (*b*) From outside the ship by the Grubbs generator or Glen Liston apparatus. (*c*) " Discoids " or wood pulp discs saturated with ½ oz. HCN may be used like " Zyklon " (see below). (*d*) By the solid " tipping " or " dumping " method, using sodium cyanide, commercial sulphuric acid and water. The water is first added to the containers, then the acid, and finally the sodium cyanide. (*e*) Calcium cyanide dust may be used in a rotary dusting apparatus for dislodging rats from deck fittings and lifeboats, or it may be blown as a fine powder through a rubber tube behind the panelling of messrooms, etc. It is sold either as Calcid or as Cyanogas, the former preparation containing a rather higher proportion of hydrogen cyanide.

The proprietary article called " Zyklon " is often used. This consists of a highly absorbent inert material saturated with liquid HCN to which a lachrymatory gas has been added, but this cannot always be relied upon as concentrations of HCN have been found after the lachrymatory effects have disappeared. " Zyklon " is supplied in hermetically sealed tins and after fumigation the residue may be disposed of as ordinary refuse.

For fumigation, the ship is divided into sections each of which is measured for volume and treated separately. The ship is then prepared. Water bottles and cabin water tanks are emptied, moist food is removed, mattresses are turned on edge, cupboard doors opened, drawers pulled out and pipe casings opened. All apertures are sealed. A ship should never be fumigated alongside another, and the quayside should be under control during the operation. Danger boards must be prominently displayed, one being hung on the offside of the ship, before fumigation is begun. A final search of the ship is made and certificates accounting for all hands must be obtained from a responsible officer and from the employers of shore labour. All keys must be accounted for—there should be no locked doors. Hydrogen cyanide may be used either in a high concentration, which allows for leakage and absorption, or in a lower initial concentration with a longer exposure. The normal amount of HCN used for empty ships is 2 oz. (57 grammes of " Zyklon ") per 1,000 cubic feet with a two hours' exposure, or 1½ oz. (43 grammes of " Zyklon ") with an exposure of four hours. The time should be doubled for loaded ships. If " Zyklon " is used the necessary amount is emptied into the hold and the hatch covered with a tarpaulin. When cabins are to be

fumigated the tins are opened on deck by operators standing with their backs to the wind, and the lids are replaced by rubber caps. The contents of the tins are finally scattered on sheets of paper placed in the cabins and alleyways. When the "Galardi" process (liquid cyanide) is used, the bottles are opened in the section to be treated and immediately inverted into rings or tripods on small trays. When the time of exposure has elapsed the operatives, working in pairs and carrying electric torches, open up hatches and other apertures. All fumigators must wear gas masks. Chemical tests for the presence of HCN are not sufficiently rapid or reliable, and no part of a ship should be considered free from gas until small animals (rats, mice or birds placed in a cage) are found unaffected after at least ten minutes' exposure.

Ships may be fumigated either loaded or unloaded. A plague-infected ship should be dealt with before unloading, and the necessity for a second fumigation will depend on conditions found during unloading. The rat population in ships has been greatly reduced in recent years. This is partly due to the operation of Article 28 of the International Sanitary Convention which deals with the periodic examination of ships for rats and partly to rat-proofing. Holmes, in an article on deratisation in Australian ports gives conclusive evidence of this. In eleven ships of old construction (which had been fumigated in an aggregate on sixteen occasions during the year) there was a total of 658, or roughly 60 rats per ship, while in 140 newer ships there were only 224 rats, or 1·6 per vessel.

While rat-proofing, accompanied by periodical fumigation, has led to a decrease in the rat population of ships, fumigation will always be necessary for insect vermin.

In the Nocht-Giemsa method of fumigation a mixture of carbon monoxide and carbon dioxide generated from incandescent coke is driven into the ship. This method has proved successful in Hamburg.

The Office International d'Hygiène Publique take the view that every authority should be free to employ any of the recognised methods and, while not laying down any standards, they recommend the following :—

Hydrogen cyanide : 2 oz. per 1,000 cubic feet of space with 2 hours' exposure, or 1½ oz. per 1,000 cubic feet of space with 4 hours' exposure.

Sulphur, burned in open pots : 3 lb. per 1,000 cubic feet of space with 6 hours' exposure.

Salforkose (a liquid mixture containing carbon bisulphide) : 2 lb. per 1,000 cubic feet of space with 4 hours' exposure.

Vapourisation of liquid sulphur dioxide : 4 lb. per 1,000 cubic feet of space with 4 hours' exposure.

Clayton gas: continue until the concentration of sulphur dioxide from the upper part of the compartment reaches 2 per cent. by volume or burn in the generator 3 lb. of sulphur per 1,000 cubic feet of space treated and give two to three hours' exposure.

(See Ministry of Health Memorandum on "The Fumigation of Ships with Hydrogen Cyanide," revised September, 1937. *J. Roy. San. Inst.*, April, 1933, pp. 563–577, Hamer; *Proc. Roy. Soc. Med.*, Sect. of Trop. Diseases and Parasitology, March, 1935, pp. 25–36, White.)

Fumigation of Aircraft.. Travel by aircraft has produced new problems. Apart from passengers travelling hundreds or thousands of miles during the incubation period of yellow fever, there is the danger of carrying infected insects which may start an epidemic in another country. The International Sanitary Convention for Aerial Navigation, 1933, Article 42, provides for the inspection and disinsectisation of aircraft at sanitary (anti-amaryl) aerodromes but, to ensure that such work is carried out efficiently, some standardisation of methods appears to be necessary.

For the destruction of mosquitoes in aircraft a suitable sprayer and insecticide (which is highly toxic to insects, innocuous to passengers, non-inflammable, non-corrosive, non-staining, stable in all climates and readily miscible with water) are essential. Water-soluble pyrethrum concentrate diluted ten to fourteen times with water immediately before spraying has proved very satisfactory. About 30 c.c. of a 1 in 15 solution per 1,000 cubic feet of space is sprayed by a nebuliser. Spraying should be carried out about a half hour before landing and all ventilators should be closed for about ten minutes after spraying.

The apparatus for disinsectisation is of two types:—

(1) A disseminator (the "phantomyst nebuliser") which converts the insecticide into a dry mist. The machine is driven electrically from the airplane supply and can be moved from cabin to cabin.

(2) The ejector type of disseminator which is suitable for all parts of the aircraft other than the cabins. This is a simple form of spray gun operated by the pressure of CO_2 in a sparklet bulb and installed in various positions in the aircraft. This method may be used during flight, thus saving time.

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CHEMOTHERAPY

The Sulphonamides

In view of the increasing number of sulphonamide drugs available and the active research being carried out in this field, exhaustive suggestions for their use are perhaps premature, but a general guide has been issued by the Medical Research Council (M.R.C. War Memo. No. 10, 1943).

Prophylaxis. Although a certain amount of work has been done on the control of cross-infection and on the prevention of venereal disease, rheumatic fever, etc., by sulphonamide compounds, their true prophylactic value has not yet been determined.

Treatment. It is important to begin the treatment of *acute* infections with a large initial, or "loading," dose, in order to raise the blood concentration of the compound to an effective level as rapidly as possible. In severe cases it is often desirable to accomplish this by giving the first dose intravenously or intramuscularly.

It is probable, though not yet proven, that exposure of micro-organisms to gradually increasing concentrations of sulphonamide—as in the patient treated with small doses—may encourage the development of a drug-resistant strain. This is less likely to happen when the drugs are given in full therapeutic dosage.

(1) *Hæmolytic Streptococcal Infections* (cellulitis, erysipelas, infected burns and wounds, meningitis, mastoiditis, otitis media, pericarditis, primary peritonitis, puerperal sepsis, scarlet fever, septicæmia, sinusitis, tonsilitis, etc.). Sulphanilamide is recommended. An initial dose of sodium sulphathiazole, sodium sulphapyridine or sodium sulphadiazine should be given intravenously in severe cases. If an added staphylococcal infection is known or suspected to be present, sulphathiazole, or sulphadiazine, is recommended instead of sulphanilamide.

(2) *Meningococcal Infections* (Cerebro-spinal fever). The compounds for use in order of choice are sulphathiazole or sulphadiazine, sulphapyridine and sulphanilamide, the last being the least potent. If excessive vomiting occurs after sulphapyridine, it should be replaced by one of the other three.

(3) *Other Forms of Purulent Meningitis* (due to Pneumococcus, Staphylococcus, H. Influenzæ, etc.). Sulphathiazole, sulphadiazine or sulphapyridine are the compounds of choice.

(4) *Pneumonia.* Sulphanilamide is relatively ineffective and sulphathiazole, sulphadiazine and sulphadimethyl-

pyrimidine are advocated. If none of these is available, sulphapyridine is suggested.

(5) *Staphylococcal Infections.* For impetigo, a local application night and morning (for not longer than seven days) of sulphathiazole in a concentration of 5 per cent. in a cream or paste should cure most cases.

For boils, carbuncles and whitlows, sulphathiazole by mouth is recommended.

For acute osteomyelitis, staphylococcal cellulitis or lymphangitis, sulphathiazole or sulphadiazine is suggested.

For staphylococcal bacteriæmia, septicæmia, pyæmia (including staphylococcal endocarditis), sulphathiazole or sulphadiazine is indicated.

(6) *Urinary Tract Infections.* The possibility of renal damage should be borne in mind and the more soluble sulphanilamide is perhaps more suitable than sulphapyridine, sulphathiazole, sulphadiazine and their acetyl derivatives. The high degree of concentration in the urine, however, helps the therapeutic action of the drugs on infections of the urinary tract so that smaller doses than those for most other infections may be used and the danger of renal blockage is proportionally reduced. In infections with hæmolytic streptococci or *Bact. coli*, sulphanilamide or sulphacetamide may be substituted.

(7) *Gonorrhœa.* In the interests of public health, it should be remembered that patients must be rendered non-infectious as early as possible. The administration of sulphathiazole is recommended ; sulphapyridine should be used if the others are not available.

(8) *Intestinal Infections.* There is no evidence, so far, that sulphonamide therapy has had any beneficial action on patients with typhoid or paratyphoid fevers or on bacterial food poisoning. In cases of dysentery, however, although sulphanilamide is not effective, good results have been obtained with sulphaguanidine and succinyl sulphathiazole. Favourable results have also been reported on the treatment with sulphaguanidine of cholera and of epidemic gastro-enteritis of the new-born.

Sulphonamides have proved very useful in war surgery and in the treatment of plague and other tropical diseases.

There are many other diseases and conditions concerning which there is still doubt about the action of these drugs or in respect of which more information is needed. The above recommendations will certainly be supplemented within a very short time.

Those called upon to use these drugs are advised to consult the M.R.C. War Memorandum No. 10, 1943, "The Medical Use of Sulphonamides."

Penicillin

Penicillin is perhaps the most remarkable of the chemotherapeutic agents that have come to light in great profusion in recent years. It would appear to be almost a specific cure for staphylococcal infections, acute and chronic osteomyelitis, carbuncles, pneumonia and empyema, infected wounds and septicæmia. It has been used successfully in the treatment of streptococcal, pneumococcal and gonococcal infections which proved resistant to sulphonamide therapy. The supply of this drug, however, is strictly limited at the present time as the difficulties of producing it on a commercial scale are very great. Its availability for general use is not yet possible.

SECTION III

INFANT MORTALITY, MATERNAL MORTALITY, MATERNAL AND CHILD WELFARE, SCHOOL HYGIENE

INFANT MORTALITY

THE infant mortality rate is the number of deaths of infants under one year of age per 1,000 registered live-births. The rate for England and Wales for 1942 was 49. These rates are not comparable year by year unless the birth-rates remain more or less constant. It has been calculated that about 30 per cent. of the infants dying in any one year were born in the preceding year. Hence the number of such deaths must be influenced by the number of births in the preceding year. The infant mortality rate is based, however, on the number of

ENGLAND AND WALES

Year.	Birth-rate.	Death-rate.	Infant Mortality rate.	Maternal Mortality. (Classification in use since 1911.)			
				No. of Deaths.	Deaths per 1,000 births.		
					Sepsis.	Other causes.	Total Puerperal Mortality.
1911 .	24·4	14·6	129	3,413	1·43	2·44	3·87
1912 .	24·0	13·4	95	3,473	1·39	2·59	3·98
1913 .	24·1	13·8	109	3,492	1·26	2·70	3·96
1914 .	23·8	14·0	104	3,667	1·55	2·62	4·17
1915 .	21·8	15·7	106	3,408	1·47	2·71	4·18
1916 .	21·0	14·3	91	3,239	1·38	2·74	4·12
1917 .	17·8	14·2	91	2,598	1·31	2·58	3·89
1918 .	17·7	17·3	98	2,509	1·28	2·51	3·79
1919 .	18·5	14·0	93	3,028	1·67	2·70	4·37
1920 .	25·5	12·4	85	4,144	1·81	2·52	4·33
1923 .	19·7	11·6	69	2,892	1·30	2·51	3·81
1925 .	18·3	12·2	75	2,900	1·56	2·52	4·08
1927 .	16·6	12·3	70	2,690	1·57	2·54	4·11
1932 .	15·3	12·0	65	2,587	1·61	2·60	4·21
1934 .	14·8	11·8	59	2,748	2·03	2·57	4·60
1936 .	14·8	12·1	59	2,301	1·39	2·41	3·80
1937 .	14·9	12·4	58	1,988	0·98	2·28	3·26
1938 .	15·1	11·6	53	1,917	0·89	2·19	3·08
1939 .	14·9	12·1	50	1,815	0·77	2·16	2·93
1942 .	15·8	11·6	49	1,673	0 42	2·05	2·47

England and Wales, 1939: Infant Mortality by Sex and Legitimacy

	Deaths per 1,000 births.					
	All infants.		Legitimate infants.		Illegitimate infants.	
	Male.	Female.	Male.	Female.	Male.	Female.
All causes:						
Under 4 weeks .	31·20	24·84	30·29	23·79	52·13	48·72
4 weeks to 3 months.	9·26	6·50	8·85	6·24	18·84	12·57
3–6 months . .	7·86	6·15	7·51	5·92	15·89	11·32
6–9 ,, . .	4·91	3·86	4·81	3·75	7·26	6·36
9–12 ,, . .	3·10	2·74	3·09	2·69	3·25	3·85
Total under 1 year .	56·33	44·09	54·54	42·39	97·38	82·82
All ages under 1 year:						
Measles . . .	0·15	0·13	0·16	0·13	0·08	0·08
Whooping-cough .	1·08	1·23	1·09	1·21	0·83	1·65
Influenza . .	0·46	0·27	0·45	0·25	0·61	0·94
Diarrhœa and enteritis . .	4·78	3·52	4·49	3·27	11·58	9·12
Premature birth .	16·72	13·69	16·27	13·08	27·16	27·58
Congenital defects (malformations and atelectasis) . .	8·62	7·22	8·48	7·16	11·88	8·73
Congenital debility and icterus . .	2·70	1·72	2·59	1·66	5·07	3·23
Developmental and wasting diseases .	28·04	22·64	27·33	21·89	44·57	39·76
Tuberculous diseases.	0·57	0·46	0·57	0·46	0·53	0·47
Convulsions . .	1·35	0·92	1·32	0·90	2·12	1·41
Bronchitis and pneumonia . . .	9·64	7·63	9·41	7·45	15·13	11·63
Other causes . .	3·98	3·10	3·62	2·72	12·18	11·79
All causes . .	56·33	44·09	54·54	42·39	97·38	82·82

births occurring in the same year as the infant deaths. Thus the rate for 1942 is the number of deaths of infants under one year of age in 1942 per 1,000 births in 1942. In the Report of the Registrar-General for 1920 it was suggested that the rate should be calculated upon the number of births occurring in the three-monthly periods in which were born the infants who have died under one year of age. Some such method is necessary in the event of a sudden alteration in the birth-rate.

"From 1881 until 1900 there was no substantial improvement in the infant mortality in England and Wales, but from 1900 to 1927 the infant death-rate fell from 154 to 70 per 1,000 births, a remarkable decline, which has also been observed in greater or less degree in every European country, and most markedly in the cities in the U.S.A. If the national returns are

ENGLAND AND WALES, 1939: NUMBER OF DEATHS IN CERTAIN PERIODS UNDER ONE YEAR AND DURING NEXT FOUR YEARS OF AGE.

	1940	
	Number of deaths.	Death-rate per 1,000 births.
Under 1 day .	5,790	9·54
1–7 days .	6,821	11·22
1–4 weeks .	4,892	8·06
4 weeks to 3 months	5,513	9·08
3–6 months .	4,948	8·15
6–9 ,, .	3,465	5·71
9–12 ,, .	2,463	4·06
		Death-rate per 1,000 living.
1–2 years	4,946	8·49
2–3 ,,	2,656	4·61
3–4 ,,	1,943	3·42
4–5 ,,	1,559	2·79
Total under 5	44,996	15·65
Deaths at all ages (civilians only)	581,557	14·54

The mortality of infants under one month (neo-natal deaths) per 1,000 births in 1940 was 28·83—the rate for developmental and wasting diseases was 20·63, for diarrhœa and enteritis 0·57.

examined more closely as to the period of the first year in which mortality occurs, it will be found that about 40 per cent. take place in the first month of life, chiefly in the first week, and that the death-rate is slightly higher for boys than for girls all through the twelve months as well as during the neo-natal period. There has been comparatively little decline in the death-rate during the first month of life (neo-natal), a fact which suggests that the causes of mortality in this period are different from the causes of mortality in the later months, and also that they are less amenable to those influences which have led to so marked a reduction in the infant death-rate as a whole." An interesting series of articles on "Death in the First Month and the First Year" appeared in *The Lancet*, 4th, 11th, 18th May and 1st June, 1940, pp. 819–21, 869–70, 912–14, 993–96, McNeil, C.

A valuable study in neo-natal mortality has been conducted in Chicago where in 1938 more than 80 per cent. of all infants dying under one year of age were examined post mortem by experienced pathologists (*J. Amer. Med. Assoc.*, July, 1938, vol. 3, pp. 134–141). The infant mortality rate in Chicago in 1940 was 28·8. In Oslo and Amsterdam in 1936 the infant mortality rates were 30 and 31 respectively and the neo-natal

death-rate 16, as compared with London's neo-natal rate in the same year of 24. For the remaining eleven months the London figure in 1936 was 42 as compared with 15 in Oslo.

"The three principal causes of death which together account for 70 per cent. of the total death-roll are :—

1. Developmental conditions, including injury during birth, prematurity, debility, convulsions, malformations, etc.
2. Respiratory diseases.
3. Gastro-enteritis.

Acute infectious diseases, influenza and tuberculosis play a relatively unimportant part. Of the three chief divisions the first group, which includes numerous vague and ill-defined causes of death, comprises almost entirely the youngest infants, and it is in this group particularly that a definite diagnosis of the cause of death is most difficult to obtain. The second and third groups chiefly include infants dying after the first month and before the end of the first year, and here, although the precise cause of death may be obscure, it is much less difficult to make a diagnosis on clinical grounds with reasonable exactitude. There is indeed a natural line of division between the deaths in Group 1, which are, broadly speaking, the neo-natal deaths—that is, those which occur during the first month of life—and those in the remaining categories." (Ministry of Health Report, No. 55, 1929, p. 65.)

The infant mortality rate is probably the best index we possess to the social circumstances of an area as the rate tends to be high in places where bad housing, overcrowding, defective sanitation, coupled with maternal ignorance and neglect, are found. Employment of married women would appear to play an insignificant part.

In an investigation which was carried out by the Ministry of Health in 1927–28 in the four selected districts of Sunderland and parts of Staffordshire, where the infant mortality was relatively high, and in Croydon and Oxfordshire, where it was relatively low, the following are some of the conclusions reached :—

"Infants born into small families experience much lower mortality than do infants born into larger families. Apart from the children of first pregnancies, infant mortality in general is found to increase gradually with the serial order of birth. The death-rate as a whole tends to be somewhat higher among first births than in the immediately subsequent group, and after that tends to rise steadily until the final group is reached where mortality is highest. As might be expected, first-born children show a high mortality in certain groups, such as birth injury, difficult labour and breech delivery, though they suffer a mortality from all causes rather lower than the average."

"Bad housing and overcrowding seem definitely prejudicial

to infant life, especially after the neo-natal period. Infants dying from post-natal causes (especially gastro-enteritis and respiratory diseases) come on the average from the more overcrowded parts of the district; syphilis is associated too with the more densely populated dwellings. Neo-natal causes on the other hand show much less tendency to be associated with overcrowding, although the averages for ante-partum hæmorrhage, premature birth and congenital malformations suggest that these causes of death are more commonly met with in crowded houses. Birth injuries and difficult labours are certainly more frequent in the less crowded homes, possibly because of the greater amount of obstetrical interference for which the better-off mother is apt to ask, and the greater number of primiparous births in association with the lower fertility in the better home."

The infant mortality rate for those counties in which agriculture is the staple industry is, on the whole, much lower than that for the counties which are classified as manufacturing centres. If the large towns are eliminated from a county the rural section provides a still lower rate.

There was no registration of **still-births** in England and Wales until July, 1927, when this became compulsory under the Births and Deaths Registration Act, 1926. There are consequently no accurate figures prior to this date as to the incidence of still-births in different parts of the country. Since 1915, however, dead-births have been notifiable to the medical officer of health in all districts and, although it may be assumed with safety that a certain number escape notification, the figures actually returned are approximately correct, and are useful for comparative purposes. In 1942 the still-birth rate was 33 per 1,000 total births.

The following table from the Statistical Review of the

England and Wales. Mortality per 1,000 Living (Both Sexes) in each of the First Five Years of Life, 1911–14, 1921–30 and 1937.

Year of Life.	1911–14.	1921–30	1937.	1937 per cent. of 1921–30.
0–1 . . .	118·16	75·51	60·56	80·2
1–2 . . .	34·06	19·88	9·72	48·9
2–3 . . .	13·68	8·51	4·47	52·5
3–4 . . .	8·32	5·23	3·32	63·5
4–5 . . .	6·14	3·90	2·83	72·6
0–5 Crude .	37·27	22·90	16·65	72·7
0–5 Standard .	37·52	23·52	16·94	72·0
1–5 Crude .	15·62	9·47	5·11	54·0
1–5 Standard .	15·54	9·37	5·08	54·2

Registrar-General for the year 1937 shows that mortality has fallen more rapidly for the years immediately following infancy than for the first year of life itself. "The second year of life usually manifests the greatest degree of annual variation and would seem to be the age of greatest susceptibility to environment."

The chief cause of the decline of infant mortality is the fall in the death-rates from congenital debility, diarrhœa and enteritis, bronchitis and convulsions, and to a less extent from infectious diseases as a whole and tuberculous diseases. The most fatal infectious diseases among infants still remain whooping-cough and measles on account of their respiratory complications.

The conditions which are most hostile to infants in the first few weeks of life are those which are most likely to be remedied by improving the health of the expectant mother and by securing better arrangements for the lying-in period.

Among the measures most likely to secure further reduction in the infant death-rate are :—

1. Improvement in the general sanitary environment and particularly in housing.

2. The provision of cleaner and more suitable food, pasteurisation of milk and the taking of fuller advantage of existing facilities for the supply of milk and meals to necessitous expectant and nursing mothers.

3. The establishment of a well-organised maternity service available for every woman who cannot afford to provide adequate facilities for herself.

4. The extension and development of the present arrangements for home visiting and infant welfare centres, so that these may be fully available for all mothers, with a view to the better education of the mother in the care and management of her own child and the protection of the child from avoidable disease or infection.

5. The provision of a domiciliary nursing service so that a trained nurse may be available for attendance in the home in connection with both minor and major maladies of infants.

6. An increase in hospital accommodation for infants who cannot properly be nursed at home, under conditions which will ensure skilled medical and nursing treatment and safety from the dangers of cross-infection. (See M.R.C. War Memo. 11, 1944).

7. Further scientific investigation and study of infant hygiene and the diseases of infants and children, and better education of medical students in this branch of the curriculum.

8. Education of the public generally in the importance of securing suitable provision for maternal and child welfare.

(Ministry of Health Report, No. 55, 1929; "Birth, Poverty and Wealth," Titmuss, R. M., Hamish Hamilton Medical Books, 1943.

MATERNAL MORTALITY

"With almost negligible exceptions, those deaths in which pregnancy or childbirth was a primary cause of death are classified by the Registrar-General into one group. This is the 'puerperal mortality,' namely the deaths 'classed to' pregnancy or childbirth, and is popularly known as the 'maternal mortality.' There remains, however, a group of cases which is excluded from the deaths 'classed to' pregnancy or childbirth by the operation of the Registrar-General's 'code,' but in which some mention of pregnancy or childbirth is made on the certificate. For the purposes of a special study of total maternal mortality, these deaths are collected by the Registrar-General and described as deaths 'associated with' pregnancy and childbirth. These two groups combined form the 'total maternal mortality' and should include all deaths of women directly due to or associated with pregnancy or childbirth.

"The group of 'associated' deaths should include women who died from a non-maternal cause but in whom pregnancy or childbirth contributed to death, since no mention should be made on the certificate of any circumstance not causally related to the death. There is reason to believe that this last condition is not always observed."

The puerperal mortality rate for any year is the number of deaths of women classed to pregnancy or childbearing (excluding deaths associated with but not ascribed to pregnancy or childbirth) per 1,000 live- and still-births registered in that year. The figure for 1942 was 2·47. Maternal mortality rates should properly be based upon the number of pregnancies, but this number cannot be ascertained owing to the absence of statistics of abortions and of multiple births. It is of interest that a voluntary system of notification of pregnancy has been in operation in Huddersfield since 1916.

Prior to 1927 still-births were not registrable and the rate was based on the number of live-births only. The inclusion of still-births lowers the maternal mortality rate by about 4 per cent.

Certain fallacies in connection with the puerperal mortality rate more apparent than real should be noted. Thus multiple births increase the denominator of the fraction though the number of maternal lives at risk is not correspondingly increased. Furthermore, maternal deaths occur in connection with abortion, ectopic gestation, eclampsia, etc., in which there

may be no live- or still-birth. Such deaths are included in the numerator of the fraction without any corresponding increase in the denominator. The effect of these fallacies is on the whole negligible. It should, however, be remembered that the number of deaths from maternal causes is small compared with that from many other causes of death. Only about 8 per cent. of the total deaths from all causes among women of child-bearing age are due to pregnancy and childbirth. Hence apparent fluctuations in the puerperal mortality rates of individual areas may often be due solely to chance variations.

If the causes of puerperal mortality are analysed it will be found that puerperal sepsis is the largest single cause (17 per cent. of deaths), puerperal toxæmia is the second, and puerperal hæmorrhage the third. The deaths from all forms of sepsis and all forms of toxæmia together account for approximately 30 per cent. of all puerperal deaths. The decline in the mortality from puerperal sepsis, first noticeable in 1936 and continuous since then, must be largely due to the introduction of sulphonamide therapy. In England and Wales puerperal mortality rates have been consistently higher in Wales and in the north-west of England. The rates of many other countries show a stationary or an upward trend, but international comparisons are unsatisfactory as there is no uniform classification of maternal deaths.

Puerperal mortality has been the subject of a number of important investigations. In 1928 a Departmental Committee was appointed by the Minister of Health and reported in 1930 and 1932. This committee made a detailed analysis of reports received of 5,805 maternal deaths, and found that 4,655 of these were directly due to childbearing and 1,150 were due to intercurrent disease. The committee were anxious to ascertain what proportion of the 4,655 deaths could be regarded as preventable, and they laid down the following requirements as being such as should be available to all pregnant and lying-in women. Any marked departure from these conditions the committee regarded as a " primary avoidable factor " :—

1. The patient should " book " and make arrangements for the confinement, should report any obvious deviation from the normal, and should carry out the instructions of the doctor or midwife.

2. The patient should receive such ante-natal care from her doctor, midwife, hospital or clinic, as should lead to the detection of albuminuria, malpresentation or marked disproportion between the fœtal head and the mother's pelvis. The examiner should obtain details of previous difficult labours and of serious illnesses.

3. The confinement should not be undertaken in an entirely unsuitable environment.

4. Such antiseptic and aseptic precautions as are generally recognised to be necessary should be taken.

5. A doctor or midwife should be available and should bring to the case a fair average degree of skill, knowledge and attention.

6. Such hospital, consultant and transport services as are essential should be available, and the doctor should take advantage of them as and when necessary.

7. A second doctor, acting as anæsthetist, should be obtained in severe cases.

8. The hospital should provide suitable facilities and its officers show evidence of special skill.

The causes of the 4,655 deaths directly due to child-bearing are shown in the following table.

Causes of 4,655 Deaths directly due to Child-bearing

		Per Cent.
Sepsis	1,727	37·1
Eclampsia	544	11·6
Operative shock, etc.	464	9·9
Ante-partum hæmorrhage	373	8·0
Post-partum hæmorrhage	296	6·3
Other toxæmias, including chorea and mania	279	6·0
Embolism	319	6·8
Abortion	578	12·4
Extra-uterine gestation	75	1·6

The committee came to the conclusion that 46 per cent. of the deaths showed a "primary avoidable factor" and that in 15·3 per cent. there was absence or inadequacy of ante-natal care ; in 19·1 per cent. error of judgment in the management of the case ; in 3·7 per cent. lack of reasonable facilities ; and in 7·7 per cent. negligence on the part of the patient or her friends.

Confidential reports on individual maternal deaths are sent to the Ministry of Health and a summary of the facts revealed is given in the annual reports of the Chief Medical Officer. (See also *Proc. Roy. Soc. Med., Sect. of Obstetrics & Gynæc.*, Vol. XXXI, November, 1937, pp. 237–250, Fairfield, Letitia.)

A Report on Maternal Morbidity and Mortality in Scotland was issued by the Department of Health for Scotland in 1935. This report dealt with 2,527 maternal deaths and concluded that the percentage of avoidable deaths was 58·7 of which 21·6 were due to negligence of the patient and 37·1 to faulty technique on the part of the attendant.

A committee of the New York Academy of Medicine made a similar inquiry in New York City, and in their report, issued in 1933, 2,041 deaths were dealt with. The percentage of

deaths considered to be preventable was 65·8, of which errors on the part of the medical attendant constituted 40·2 per cent., errors on the part of the patient 24·1 per cent., and errors on the part of midwives 1·4 per cent.

Social and environmental factors in relation to puerperal mortality. In the Ministry of Health's Report on an Investigation into Maternal Mortality (1937) the following conclusions were reached :—

1. The risk of maternal death increases steadily with advancing age. The risk at the first is apparently greater than at succeeding confinements until about the eighth and those subsequent to the latter, and the third confinement appears to carry the least risk.

2. Districts in which there are areas with bad housing and overcrowding are just as likely to have low rates of puerperal mortality as those in which the housing is good and the overcrowding less. The observed variations in puerperal mortality rates do not show any consistent association with corresponding variations in economic conditions, the extent of unemployment being taken as the index.

3. In a series of areas investigated the proportion of women employed in any "gainful occupation" and the rates of puerperal mortality tend to rise or fall together, and this tendency is somewhat emphasised when the occupation is industrial. In those areas in which textile work was numerically the principal occupation of the adult woman, the rate of puerperal mortality exceeded five per 1,000 live births during 1924–33.

4. For the country as a whole conditions associated in any year with a high prevalence of scarlet fever and erysipelas, and of diphtheria, seem also to be associated with a high prevalence of puerperal sepsis. The death-rates from all puerperal causes and from puerperal sepsis, and the notification rates for puerperal sepsis, are highest in the first and fourth and lowest in the third quarters of the year.

5. **Abortion.** The term "abortion" is generally taken to mean the expulsion of the products of conception from the uterus at any period up to the 28th week of pregnancy. Whether spontaneous or artificially induced, abortion is an important factor in the puerperal mortality rate of the country since approximately 14 per cent. (excluding abortions classed as criminal) of all puerperal deaths are due to this cause. An Inter-Departmental Committee on Abortion was appointed in 1937 and in its report issued in 1939 the Committee recorded the general impression that the annual number of abortions is between 110,000 and 150,000 of which about 40 per cent. are criminal. The practice of artificially induced abortion appears

to be increasing and is not restricted to any one social class. It is responsible for a greater proportion of deaths among unmarried than among married women and is largely responsible for the higher maternal mortality rate of unmarried women. Various attempts have been made to estimate the probable frequency of abortion in various countries. In the Epidemiological Report of the Health Section of the League of Nations, 15th July, 1930, the frequency of abortion in Germany in 1924 was estimated to be as high as two to every three confinements and in 1927 as nearly one abortion to every confinement. In Warsaw the proportion of abortions to confinements was estimated to be one to 4·15, and in France practically one abortion to one confinement. Investigations by Whitehouse in Birmingham showed an incidence of one abortion to every 4·7 births. (Proceedings of the Royal Society of Medicine, 1930, Part I., p. 241.)

Deaths due to sepsis following abortion represent a very large proportion (at least 66 per cent.) of the total deaths due to abortion.

The influence of good nutrition of the mother during the pre-natal period on the whole course of pregnancy and on the health of the child during the first six months of its life has been demonstrated by interesting work which has been carried out in Toronto in recent years where the pre-natal diets of 400 women with low incomes were studied. One group found to be on a poor diet was left as a control, a second group on a poor diet was improved by supplying food during the last three or four months of pregnancy, and a third group found to have moderately good pre-natal diets was improved by education alone. The supplements that were provided for the second group were daily 30 oz. of milk, 1 egg and 1 orange, once a week two 16-oz. tins of canned tomatoes and ½ lb. of cheddar cheese. A dose of dried wheat germ which contained malt and added iron, and a capsule of Viosterol containing 2,000 international units of vitamin D were also given daily.

During the whole course of pregnancy the mothers on a good or supplemented diet enjoyed better health, had fewer complications and proved better obstetrical risks than those left on poor pre-natal diets. The incidence of miscarriages, stillbirths and premature births in the women on poor diets was much increased. The incidence of illness in the babies up to the age of six months and the number of deaths resulting from these illnesses were many times greater in the poor diet group (*J. of Nutrition*, November, 1941, vol. 22, No. 5, pp. 515–526).

MATERNAL AND CHILD WELFARE

Regulation of the practice of midwifery, as provided for in the Midwives Act, 1902, was a necessary first step towards a

complete scheme for safeguarding the health of expectant mothers, lying-in women and young children. The next step was taken with the passing of the adoptive Notification of Births Act, 1907. This notification of births to the local M.O.H. was something in addition to registration of births with the local registrar and was introduced to afford an opportunity to local authorities to offer advice and assistance to nursing mothers mainly in connection with the rearing of their infants. In 1915 such notification was made compulsory in all areas and local authorities were given power to undertake maternity and child welfare work. The Maternity and Child Welfare Act, 1918, extended somewhat the earlier provisions and the **P.H.A., 1936,** consolidated much of the previous legislation.

This Act, Sections 200–205, defines "**welfare authorities**" as county borough councils and such county councils and district councils as, prior to the commencement of the Act, were local authorities under the Notification of Births Acts, 1907 and 1915. Where in any county district the welfare authority is not the local authority for elementary education, the Minister may by order transfer the maternity and child welfare work to the authority for elementary education if he is satisfied that this would conduce to more efficient administration.

Every welfare authority must appoint a maternity and child welfare committee which may be a committee of the authority appointed for other purposes (*e.g.* the public health committee) or a sub-committee of such a committee. All matters relating to maternity and child welfare shall stand referred to this committee, save the power of levying a rate or of borrowing money. The authority may appoint as members of the committee persons who are not members of the authority, but at least two-thirds of the committee must be members of the authority. At least two members of the committee must be women.

The requirements regarding **notification of births** are as follows :—

1. The birth of any child, born alive or dead after the twenty-eighth week of pregnancy, must be notified in writing to the M.O.H. of the welfare authority within thirty-six hours by (*a*) the father, if he is resident in the house at the time of the birth, or (*b*) any person in attendance on the mother within six hours of the birth.

2. The welfare authority must supply stamped and addressed post-cards printed in a special form, on application, to all practitioners and midwives residing or practising in the district.

3. This notification is not a substitute for the ordinary registration of births, and the local registrar may inspect all notices of births received by the M.O.H.

4. There is a penalty not exceeding 20*s*. for default, unless the person charged can prove he had reason to believe that some other person had sent the notice.

5. The M.O.H. of a district council (other than a welfare and local supervising authority) must send duplicates of notifications to the county M.O.H.

A welfare authority may, subject to the general approval of the Minister, make arrangements for the care of expectant and nursing mothers and of children who have not attained the age of five years and are not being educated in schools recognised by the Board of Education—provided that nothing in this Act shall be taken to authorise the establishment by a welfare authority of a general domiciliary service by medical practitioners.

In February, 1943, the Ministry of Food introduced a National Milk and Vitamins Scheme which simplified earlier procedure for the supply of milk, cod liver oil and orange juice free or at reduced cost to expectant and nursing mothers and young children. National dried milk is obtainable, if required, in place of liquid milk for infants under the age of one year, and, in certain circumstances, for expectant mothers and children up to the age of five years. Such assistance is obtainable through children's ration books and, in the case of expectant mothers, on the presentation of her ration book and medical certificate which must be signed by a registered medical practitioner, a certified midwife, or a health visitor. Application forms are required only when free supplies are claimed. The latest figures available on 1st October, 1943, indicated that there were 3,537,579 beneficiaries under the scheme. Arrangements have also been made for the granting to expectant mothers of priority supplies of shell eggs, dried eggs, meat, oranges, and for extra clothing coupons. Only one certificate is required and this must show the approximate date of confinement. Meals may still be provided to expectant and nursing mothers and children under five by welfare authorities. A useful Memorandum on "The Feeding of Children from One to Five Years" was issued by the Ministry of Health in March, 1942.

The Minister may make regulations prescribing the qualifications of welfare medical officers and health visitors and no person shall be appointed unless qualified in accordance with the regulations (see p. 14).

If the occupier of a factory or workshop knowingly allows a woman to be employed therein within four weeks after childbirth, he is liable to a fine not exceeding £5.

The following headings of a **complete maternity and child welfare scheme** form part of an interesting memorandum on health visiting and maternity centres prepared by the Local Government Board as long ago as July, 1914.

1. Arrangements for the local supervision of midwives.
2. Arrangements for—
   (a) An ante-natal clinic for expectant mothers.
   (b) The home visiting of expectant mothers.
   (c) A maternity hospital or beds at a hospital in which complicated cases of pregnancy can receive treatment.
3. Arrangements for—
   (a) Such assistance as may be needed to ensure the mother having skilled and prompt attendance during confinement at home.
   (b) The confinement at a hospital of sick women, including women having contracted pelves or suffering from any other condition involving danger to the mother or infant.
4. Arrangements for—
   (a) The treatment in a hospital of complications arising after parturition, whether in the mother or in the infant.
   (b) The provision of systematic advice and treatment for infants at a baby clinic or infant dispensary.
   (c) The continuance of these clinics and dispensaries so as to be available for children up to the age when they are entered on a school register.
   (d) The systematic home visitation of infants and children not on a school register.

MATERNAL WELFARE

Ante-natal services. Health visitors should endeavour to get in touch with the expectant mothers in their districts and induce them to place themselves under routine supervision. Should a midwife be engaged, it is her duty to keep a record of the ante-natal supervision, including information regarding urine tests and pelvic measurements. She must also send for medical aid should any abnormality occur.

Ante-natal clinics should be convenient of access and should have suitable waiting-room accommodation, dressing cubicles, a well-lighted and heated examination room, water-closet accommodation and facilities for urine testing. The doctor in charge should be assisted by midwives and health visitors.

Expectant mothers should attend the clinic monthly during the early months of pregnancy, twice a month from the fifth to the seventh month and then weekly until the time of confinement. An early general examination of the woman should be made and pelvic measurements should be taken. The urine should be tested and the blood pressure measured at each visit. At the thirty-second and the thirty-sixth weeks special attention should be directed towards estimating the position of the fœtus

and the relation of the head to the pelvis. An internal examination ought to be made at least once in each case. The councils of certain rural counties have arranged for domiciliary ante-natal supervision to be provided by general practitioners. In one instance such supervision includes a general medical examination of the woman early in pregnancy and a full obstetrical examination after the thirty-fourth week. A fee of 5*s*., together with travelling expenses, is paid in respect of each examination. It is essential that the services of a consultative ante-natal clinic should be made available for all cases of doubt or difficulty.

Careful records should be kept of the women attending and there should be free interchange of information between the medical officer of the clinic, the attendant engaged for the confinement, and the obstetric consultant. Home visits should be paid by health visitors to ascertain whether the advice given at the clinic is being followed and a prompt visit should be paid if a woman has failed to keep her appointment at the clinic. Much of the work of those engaged in ante-natal supervision should be educational in character, and a sufficient number of clinic sessions should be arranged so as to prevent overcrowding. Dental treatment at reduced rates should be made available and extra nourishment should be provided where necessary.

During 1942 the percentage of expectant mothers who attended ante-natal clinics or received ante-natal care through welfare authorities' arrangements with private practitioners in England and Wales was 75·9 per cent. of the total registered births, as compared with 27·3 in 1930. (See Interim Report of the Departmental Committee on Maternal Mortality and Morbidity, 1930, Appendix F, p. 140.)

Midwives. The training and practice of midwives are regulated by the **Midwives Acts, 1902–1936.** The 1902 Act established a Central Midwives Board consisting of representatives appointed by the Ministry of Health, the Royal Colleges of Physicians and Surgeons, the Society of Apothecaries, the Incorporated Midwives Institute, the Queen's Institute of District Nursing, the Association of County Councils and of Municipal Corporations and the Society of Medical Officers of Health. The Board is now subject to the administrative control of the Minister of Health. It has the duty of publishing annually a roll of certified midwives, of suspending from practice, or removing from the roll the names of, midwives disobeying the rules of the Board or guilty of other misconduct, and of framing rules regarding—

(*a*) admission to the roll of midwives;
(*b*) the course of training and conduct of examinations;
(*c*) the practice of midwives;

(*d*) the conditions under which midwives may be suspended from practice.

Any woman aggrieved by a decision of the Board to remove her name from the roll may appeal to the High Court within three months. No further appeal is allowed.

On 31st March, 1943, the Roll of Midwives contained the names of 67,112 women, although a large proportion had not indicated their intention to practise midwifery. Of the women enrolled in 1940, only 58 per cent. were practising in 1941.

Local supervising authorities for the purposes of the Midwives Acts are the councils of counties and of county boroughs, but the Local Government Act, 1929, provided that the Minister might by order transfer the local supervision of midwives to a district council conducting maternity and child welfare work under a whole-time M.O.H. Local supervising authorities are responsible for the inspection of midwives and have the power to suspend a midwife from practice if such a step appears necessary to prevent the spread of infection. In such a case, a midwife, if not herself in default, is entitled to recover from the local supervising authority reasonable compensation for loss of practice. Local supervising authorities have the duty of investigating charges of misconduct brought against midwives and, where necessary, of reporting cases to the Central Midwives Board.

No woman may use the title of midwife unless certified under the Acts and no person, unless certified, may attend women in childbirth otherwise than under the direction and personal supervision of a registered medical practitioner. Medical students, pupil midwives and persons rendering assistance in case of "sudden and urgent necessity" are exempt from this latter provision. The 1936 Act contains a section which states that if the Minister is satisfied that an adequate service of domiciliary midwives has been provided in an area he may, by order, apply to the area the following provision :—

If any person, being neither a certified midwife nor a registered (in the general part of the register of nurses) nurse, or a male person, receives any remuneration for attending in that area as a nurse on a woman in childbirth or at any time during the ten days after childbirth, that person is liable to a fine not exceeding £10. (This provision does not apply to medical students, pupil midwives or other persons employed in certain institutions.)

No certified woman may employ an uncertified woman as her substitute. Every certified midwife must notify the local supervising authority of her intention to practise in their area and such notice must be renewed annually in January if she intends to continue her practice.

A midwife is required to call in a medical practitioner in any emergency as defined by the rules of the Board. The local supervising authority must pay the prescribed fee to the doctor and may recover the sum from the patient or her husband. The Minister may make regulations fixing the scale of such fees and prescribing the conditions subject to which such fees will be payable (p. 253). He may also make regulations prescribing the qualifications of persons appointed as supervisors of midwives (p. 16).

The 1936 Act required every local supervising authority to make arrangements for securing for their area an adequate number of whole-time certified midwives to act either as midwives or as maternity nurses. The authority could either employ the midwives themselves or arrange for their provision by welfare councils (*i.e.* by councils, not being local supervising authorities, which had established a maternity and child welfare committee) or by voluntary organisations. By the end of 1938 there were in England 169 local supervising authorities under the Midwives Acts and all had inaugurated domiciliary midwifery schemes. About four-fifths of the work of domiciliary midwives in England in 1938 was undertaken by those employed by local authorities or by voluntary associations.

Local supervising authorities must fix scales of fees for the attendance of the midwives as midwives or as maternity nurses and must recover such fees, if necessary as a civil debt, from the persons liable. The fees may be remitted in whole or in part in the case of necessitous persons.

During the initial period, 1937 to 1942, an annual Exchequer grant was paid to each authority in respect of the additional expenditure incurred on the new service of midwives.

The Report of the Midwives Salaries Committee under the chairmanship of Lord Rushcliffe recommended a general improvement in the rates of pay and conditions of service of midwives employed by local supervising authorities. It aims at standardising salaries by fixing a minimum rate but, to prevent competition amongst local authorities, it is probable that a national scale of payment will eventually be adopted.

The Central Midwives Board may frame rules requiring midwives to attend post-graduate courses of instruction and every authority must arrange for the provision of such courses for their midwives.

The Rules of the Central Midwives Board give guidance to the midwife in all matters relating to her training and practice. The period of training is one year for State-registered nurses and two years for other women. It is divided into two parts, the first extending over six months for State-registered nurses and eighteen months in other cases, and the second part

extending over six months in all cases. The aim of the first part is to provide every pupil-midwife, whether she intends to practise midwifery or not, with a thorough grounding in the subject under the best available conditions, and the second part of the course is designed specially to meet the needs of the pupil-midwife who intends to practise midwifery (see p. 15).

The lying-in period is defined as meaning the time occupied by the labour and a period of not less than fourteen days thereafter. The Rules require the midwife to undertake the ante-natal supervision of her cases and to keep notes of her ante-natal observations on a special form.

A midwife must give the local supervising authority every reasonable facility for inspecting her register of cases and other records, her bag of appliances, her place of residence, and, when thought necessary by the authority for preventing the spread of infection, her clothing and her person, and for investigating her mode of practice.

A midwife in charge of a case of labour must not leave the patient without giving an address by which she can be found without delay; and, after the commencement of the second stage, she must stay with the patient until the expulsion of the placenta and membranes, and as long after as may be necessary.

Midwives must send for medical aid in all cases of illness of the patient or child or of any abnormality occurring during pregnancy, labour or lying-in. For this purpose the midwife must use the form specially provided. In particular she must send for medical aid in the case of a lying-in woman showing a rise of temperature to 100·4° F. for twenty-four hours, or its recurrence within that period, or a rise of temperature above 99·4° F. on three successive days, and in all cases of inflammation of, or discharge from, the eyes of an infant (see Regulations, p. 262).

A midwife must not lay out a dead body unless it be the body of a patient or child upon whom she has been in attendance as midwife or maternity nurse at the time of death.

Notification on the prescribed form must be sent to the local supervising authority by the midwife in the following cases :—

(*a*) When medical aid has been sent for.

(*b*) When the death of the mother or child occurs, whether or not a doctor was present at the time of death.

(*c*) In all cases of still-birth when no doctor was in attendance at the time of the birth.

(*d*) When she has laid out or assisted to lay out a dead body for burial.

(*e*) When she has been in contact with a person, whether or not a patient, suffering from puerperal fever or from any other condition which may raise suspicion of infection, or is herself liable to be a source of infection.

(*f*) Whenever it is proposed to substitute artificial feeding for breast-feeding.

(*g*) Intention to practise in a district and change of name or address.

An Advisory Memorandum was issued by the Central Midwives Board in 1936 indicating the drugs which midwives might reasonably use in the course of their practice and, in particular, stressing the care that must be taken in respect of drugs subject to the Dangerous Drugs Regulations. The Memorandum also laid down the conditions under which a midwife might administer gas and air by Minnitt's or similar apparatus. These conditions include (i) prior instruction in the use of the apparatus, (ii) prior examination of the patient by a doctor, (iii) the presence in the room of another person possessing some nursing training.

(*Public Health*, June, 1938, pp. 257–265, " The Operation of the Midwives Act, 1936 " ; " Local Authorities and the Midwifery Service," Public Health, June, 1943, p. 101, Sir William Fletcher Shaw.)

Obstetric services. In the Ministry's Maternal Mortality Report, 1937, the conclusion is reached that the most important factor influencing the maternal mortality rate is the standard of midwifery practice. It is pointed out that during recent years opportunities afforded general medical practitioners to obtain practical experience in obstetrics have become fewer owing to (*a*) the fall in the birth-rate, (*b*) the great increase in confinements in institutions, and (*c*) the number of confinements for which midwives are responsible. It should be remembered that a midwife is required by the Rules of the Central Midwives Board to send for medical aid in certain circumstances, and that, although local supervising authorities are required to pay the fees of the doctor so called in, they have no voice in the selection. These fees vary from 2*s*. 6*d*. for a consultation at the doctor's surgery to £3 3*s*. for attendance of the doctor at the confinement and all subsequent visits to the mother and child during the first fourteen days inclusive of the day of birth (The Medical Practitioners (Fees) Regulations, 1940.)

In Circular 1705 (14th June, 1938) the Minister of Health suggested that local supervising authorities, in consultation with local organisations of registered medical practitioners, should draw up lists of practitioners willing to be called in by midwives in an emergency. The authority should also set up an advisory committee for their area consisting of the M.O.H. (as chairman), two general practitioners and two obstetric consultants. This committee would have the duty of scrutinising the list and of making such recommendations

to the authority as, for instance, that a practitioner should be required to take a specified period of post-graduate training as a condition of the continued inclusion of his name on the list, or that, where required in the public interest, the name of a practitioner should be removed from the list. A copy of the list should be supplied to every midwife employed in connection with the authority's scheme for domiciliary midwifery.

Practitioners rendering medical aid should form an integral part of the maternity service and should freely avail themselves of the consultant and other facilities provided by the local authority. Other recommendations of the Ministry's Report, 1937, designed to improve the standard of obstetrics are :—

(1) The establishment, under the direction of the medical officer of health, of an adequate service of obstetric consultants—

(*a*) to assist medical practitioners, who undertake domiciliary midwifery, in cases of doubt or difficulty in the ante-natal period, at the time of confinement and during the puerperium ;

(*b*) to conduct ante-natal and post-natal clinics to which patients may be referred by general practitioners or from the routine ante-natal and post-natal clinics ;

(*c*) to exercise clinical supervision over the in-patient treatment of the maternity patients in the local authority's own institutions ;

(*d*) to supervise the treatment of patients suffering from puerperal sepsis ;

(*e*) to be responsible for the emergency domiciliary service for cases of grave obstetric abnormality in which removal to hospital is contra-indicated ;

(*f*) to assist the medical officer of health in the confidential investigation of the circumstances associated with each maternal death occurring in the area.

(2) Emergency units ("flying squads") should be provided whereby the staffs of the maternity departments will be available for the domiciliary treatment of maternity patients whose condition is too grave to justify removal to hospital. (*B.M.J.*, 24th September, 1938, p. 654, Murray, E. F.)

(3) Satisfactory arrangements should be made for the accommodation and treatment of patients suffering from puerperal sepsis and from abortion.

Freshly sterilised outfits for use at the time of the confinement and during the puerperium should be provided by the local authority. The local authority may arrange for a "home help" or woman competent to look after the home during the period of confinement. These "home helps" are paid at a rate fixed by the local authority and the mother contributes the whole or part of the cost (see Min. of H. Circular 2729,

November, 1942, with accompanying Memorandum). It should be remembered that a woman who is herself insured or is the wife of an insured man is entitled to maternity benefit under the system of National Health Insurance (see p. 654).

Institutional maternity accommodation must also be provided and should, if possible, be associated with a general hospital where facilities for diagnosis and treatment are readily available (see p. 209). The nursing staff of the institution should include an experienced sister-midwife, holding, if possible, the certificate in midwifery of the Central Midwives Board, with a sufficient number of staff-nurse-midwives and midwives. Separate trained midwifery staff should be provided for the suspect and observation units. It has been suggested that there should be one nurse for every three patients by day and one for every eight or ten by night in addition to extra labour-ward staff.

Puerperal sepsis. Puerperal fever was made compulsorily notifiable in 1899, but this condition ceased to be notifiable, outside London, when the Public Health Act, 1936, came into operation on the 1st October, 1937. Regulations issued in 1939, however, require medical practitioners to notify to the medical officer of health all cases of puerperal pyrexia, which is defined as being " any febrile condition occurring in a woman within twenty-one days after childbirth or miscarriage in which a temperature of 100·4° F. (38° C.) or more has been sustained during a period of twenty-four hours, or has recurred during that period." These Regulations do not apply to London where the condition is still notifiable under the P.H. (Notification of Puerperal Fever and Puerperal Pyrexia) Regs., 1926. The notification must be made on a special form, and a copy of it must be sent within twenty-four hours by the medical officer of health of a county district to the medical officer of health of the administrative county. The usual fee of 2*s*. 6*d*. is to be paid to the medical practitioner notifying the case. Welfare authorities are empowered, with the sanction of the Minister of Health, to make provision for the special treatment of women suffering from puerperal pyrexia, for consultation with an obstetric specialist, for skilled nursing or for institutional accommodation. The following is the prescribed form of notification, and it will be seen that the medical practitioner is asked to state whether he desires to have certain types of specified assistance in connection with his case.

To the Medical Officer of Health of..

I hereby certify that..

now at...

is, in my opinion, suffering from puerperal pyrexia as defined in the Puerperal Pyrexia Regulations, 1939, and *I desire to have a bacteriological examination of the lochia.

Married or single.................... Age..............................

Date of onset of disease..

Date of birth of child...

*I desire also

(i) to have a second opinion on the case ;
(ii) to have a bacteriological examination of blood ;
(iii) that the patient be admitted to hospital ;
(iv) that trained nurses be provided.

*Facilities are available for all necessary treatment.

*The case occurs in my private practice.
in my practice as medical officer of a public body or institution.

Signed..

Address..

Dated this................day of.................19 .

* *Strike out inappropriate clauses.*

In return for any assistance given by the local authority, medical practitioners may reasonably be requested to supply information regarding cases of puerperal pyrexia or sepsis.

Puerperal sepsis is usually due to infection by hæmolytic streptococci. These organisms are rarely found in the uterine passages before delivery, but not infrequently streptococci of the same serological type as those detected in swabs taken from the cervix of a case of puerperal sepsis have been obtained from the nose or throat of one or more persons who have been closely associated with the woman during labour or the lying-in period. Knowledge of the causation and mode of spread of puerperal infection is being constantly augmented and the newer methods of treatment, especially by chemotherapy, have had notable results. The value of drugs of the sulphonamide group in the treatment of puerperal fever patients infected by hæmolytic streptococci has been definitely established largely as a result in this country of the work of Colebrook and his colleagues. During 1931–35 the fatality rates from such infections in Queen Charlotte's Hospital was 22·8 per cent., whereas among sixty-four prontosil-treated cases in 1936 the fatality rate was only 4·7 per cent. Since then the effect of sulphonamide therapy may be seen in the progressive decline in the mortality rate from puerperal sepsis throughout the country.

On the occurrence of puerperal pyrexia steps should be taken immediately to ascertain the cause of the rise in temperature and the attendant contacts must not conduct a labour or nurse any other puerperal woman until the existence of infection of the genital passages with hæmolytic streptococci has been excluded. A vaginal swab should be taken in every case of puerperal pyrexia unless the practitioner can be quite certain that the fever is not due to infection of the genital tract.

The bacteriological report should be available in twenty-four hours and if the swab yields hæmolytic streptococci every effort should be made to ascertain whether any attendant was the possible source of infection. To this end swabs should be taken from the nose and throat and from any skin lesion of the doctor or midwife. These swabs should be taken and sent for examination at the same time as is the patient's vaginal swab if streptococcal infection of the patient is suspected from the outset. Swabbing should be limited to persons who might carry infection to other parturient women, *i.e.*, primarily doctors and midwives.

Any attendants found to be harbouring hæmolytic streptococci must cease to attend labours or to nurse other puerperal women until three negative swabs taken at daily intervals from both nose and throat have been obtained and clinical signs, if any, have disappeared. If the strains from any contact are found not to belong to Group A (Lancefield), the carrier condition of that contact may usually be ignored.

Even a single case of puerperal infection should be carefully investigated under the direction of the medical officer of health. The history of the patient should be taken with special reference to septic or other infective conditions in herself or in others with whom she has been in contact, and a most detailed account of the character and conduct of the confinement should be obtained. If a domiciliary case is being investigated the health, home circumstances and routine practice of the midwife should be minutely examined. All temperature and other records of maternity cases attended by the midwife in recent months should be scrutinised. The midwife and her equipment should be carefully " disinfected " before she is permitted to resume practice, but care should be taken to see that midwives are not suspended needlessly or for an unduly long time.

Institutional investigation. In addition to inquiries into the history of the patient and the particulars concerning the confinement, the following should be investigated :—

1. All records over a period of months of maternity patients and of infants ;
2. the routine midwifery practice of the institution ;
3. the procedure adopted for the isolation of patients showing a rise of temperature or other suspicious symptoms ;
4. the staffing of wards and the duties of the nurses—in the case of general hospitals, the duties, if any, other than obstetric undertaken by the medical and maternity staffs ;
5. the tabulated histories, including the date of onset of all suspicious signs, of patients about whom any doubt exists ;
6. the exact location of each ward where cases occurred ;
7. details of the health of the medical, nursing and domestic

staffs over a period of months; adequate bacteriological investigation should be undertaken where necessary.

Other general inquiries. (*a*) An examination should be made of the records in the public health department of all notifications of scarlet fever, erysipelas and puerperal pyrexia in order to ascertain the areas of prevalence of these infections.

(*b*) Examination of the recent death certificates of infants should be undertaken in order to ascertain whether septic infections may have been a cause of death.

(*c*) Domiciliary inquiries should be made respecting the health of mothers and of infants who have been discharged from a maternity department when an outbreak of puerperal sepsis has occurred in that department. Such outbreaks may be associated with minor and major manifestations in infants which may have developed subsequent to the discharge of the infants from hospital.

Nursing and institutional facilities. Arrangements should be made for the home nursing of patients not removed to hospital. Adequate provision should be made in every area for the admission to hospital and the treatment under expert supervision of cases of puerperal sepsis. The accommodation should be provided in single wards entirely unconnected with those used for other maternity patients. A properly equipped treatment room should be available, the nursing staff should not undertake any other midwifery duties and the work should be supervised by an expert obstetrician. (Min. of Health Memo. 226/Med., 1939.)

Post-natal services. At least two medical examinations should be made, the first at the end of the lying-in period, and the second six to eight weeks after confinement. Such examinations may be conducted either by the patient's own medical attendant or at special clinic sessions. The services of a consultant gynæcologist should be available, and hospital accommodation should be provided for women requiring in-patient treatment.

Advice in contraception. The Minister of Health has decided that advice on contraceptive methods may be given at maternity centres to married women who are either expectant or nursing mothers already in attendance at the centre and in whose case further pregnancies would be detrimental to health. It is also open to a local authority to institute a gynæcological clinic, under the Public Health Act, and to provide such advice to married women suffering from gynæcological conditions or other forms of sickness, physical or mental, which are likely to render pregnancy detrimental to health. (Ministry of Health Memorandum, 153/M.C.W., March, 1931; Circ. 1208, 14th July, 1931; and Circ. 1408, 31st May, 1934.)

CHILD WELFARE

Infant welfare centres should be placed at convenient points in each district, serving the area of one or two health visitors. Such centres as a rule form part of a maternity and child welfare centre with which is frequently associated a school clinic. There is a tendency nowadays to combine as many as possible of a local authority's medical activities in one large building, known as a health centre. A maternity and child welfare centre should include a pram shelter, waiting-rooms, weighing room, nurses' room and doctor's rooms. There should be adequate w.c. accommodation. Old buildings are sometimes adapted for use as centres, but it is much more satisfactory to design and build special premises (see Fig. 4, pp. 260 and 261).

There should be one health visitor for approximately every 250–280 births in a district per year, but the number required varies, of course, with the character of the area. Information regarding the notification of births occurring in her area is sent to each health visitor by the M.O.H., and it is her duty to visit the homes concerned—if practicable before the midwife has ceased attendance on the case or, in any event, as soon as possible afterwards. In order to avoid home visiting by too many people, the same woman may be appointed as health visitor, school nurse, tuberculosis nurse and infant protection visitor for her area. In rural areas she may be the district nurse midwife as well, but only an exceptional woman can undertake satisfactorily all these duties. Visits are usually paid fortnightly for the first six months, monthly from six to nine months and then half yearly until the child is five years of age. If the mother decides to take her infant to the centre, she should be encouraged to attend every four to six weeks for the first year unless progress is unsatisfactory, and thereafter every three or six months. At the centre not more than thirty to forty infants can be dealt with satisfactorily at one session of two and a half hours, and the medical officer cannot see more than about twenty-five, including new cases. Much of the success of the work depends on the co-operation of the medical officers and health visitors with the local practitioners and midwives.

Assistance is often given at such centres by voluntary workers, and the centre is used as an agency for the distribution under the National Milk and Vitamins Scheme, of dried milk, cod liver oil, orange juice, etc., free or at less than cost price to mothers and infants in need of such help. Convalescent home treatment and dental treatment are usually arranged through the centre. The work of the centre should be primarily educational in character, and should not be directed either towards public assistance or the treatment of disease. The

number of children under one year of age who attended centres in England and Wales during 1942 for the first time represented 69·3 per cent. of the notified live-births.

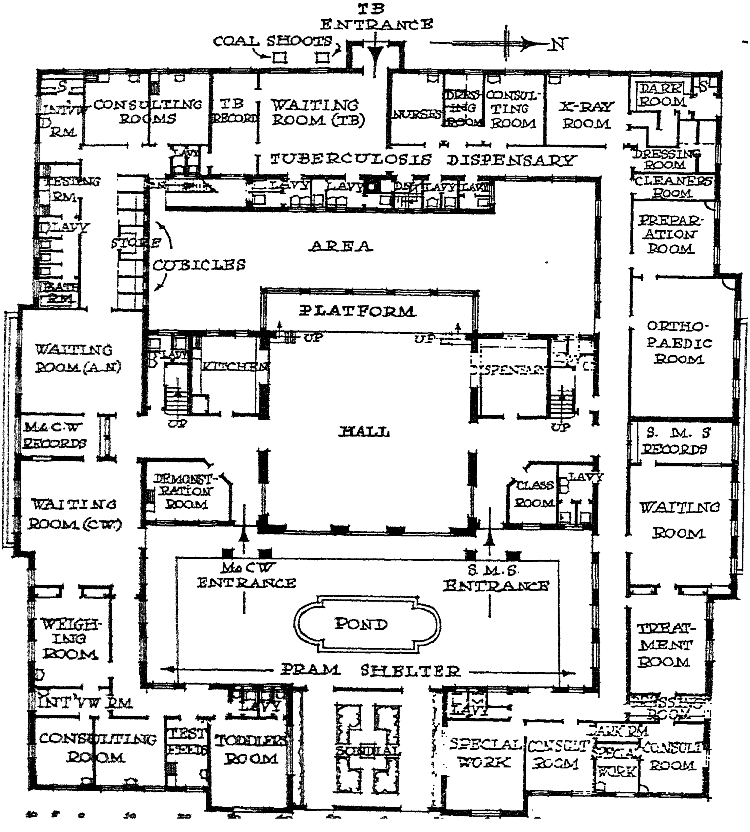

Fig. 4a. Model Health Clinic. (Ground floor plan.)

(Designed by the Ministry of Health with the assistance of the Board of Education, the Department of Health for Scotland, and a number of English and Scottish Medical Officers of Health, and reproduced with the permission of H.M. Stationery Office.)

Ophthalmia neonatorum has been responsible in the past for a large proportion of the cases of blindness in schools for the blind. The incidence is decreasing, due probably in large

measure to the greater care exercised by doctors and especially by midwives at the time when an infant is born. In 1940 the

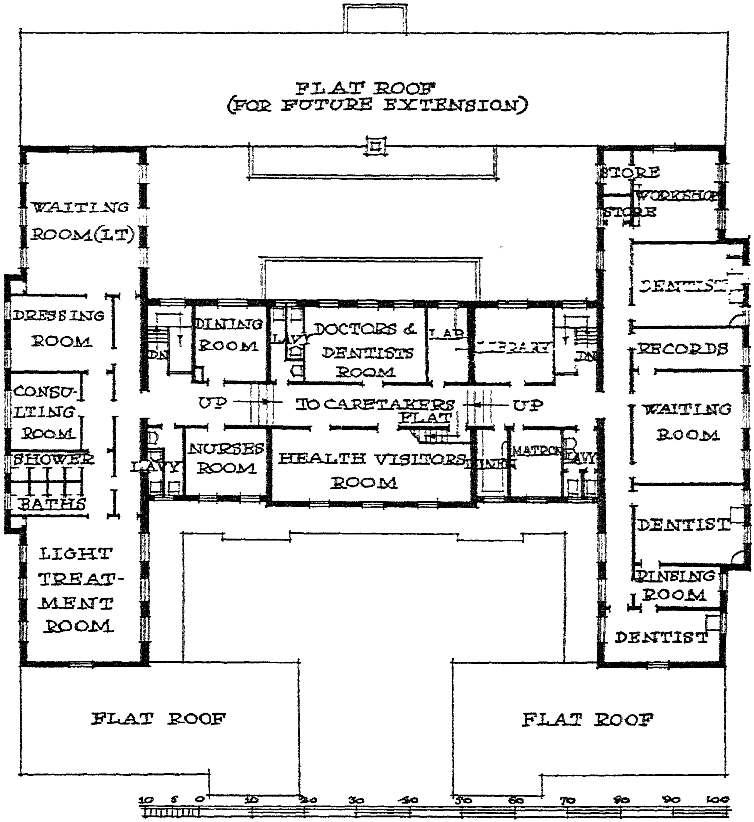

FIG. 4B. Model Health Clinic. (First floor plan.)

(Designed by the Ministry of Health with the assistance of the Board of Education, the Department of Health for Scotland, and a number of English and Scottish Medical Officers of Health, and reproduced with the permission of H.M. Stationery Office.)

number of cases notified in England and Wales was 4,390. The condition was formerly notifiable to the M.O.H. by both doctor and midwife, but under the Public Health (Ophthalmia Neo-

natorum) Regulations, 1926 to 1937, the onus of notification is placed on the doctor alone. Notification must be sent to the M.O.H. of the maternity and child welfare authority which in county districts may be either the district council or the county council. Arrangements must be made for the prompt interchange of information between the county and the district M.O's.H. Ophthalmia neonatorum is defined as "a purulent discharge from the eyes commencing within twenty-one days from the date of birth." Midwives are required by the Central Midwives Board to call in medical aid "for any inflammation of, or discharge from, the eyes, however slight," and to inform the local supervising authority. The local M.O.H. should see that early and thorough treatment, including nursing, is provided for each case, and should arrange for the health visitor to visit the home regularly. If possible, the mother and infant should be admitted to an institution, especially in the case of severe infection. Treatment with sulphapyridine has proved most successful. (An excellent discussion will be found in *Public Health*, July, 1934, p. 314, Lees.)

Vulvo-vaginitis in children occurs not infrequently in institutions and may be gonococcal or non-gonococcal. Of 627 cases occurring in L.C.C. hospitals 32 were gonococcal, and of 1,219 cases in Great Ormond Street Hospital, 249 were gonococcal and 21 doubtful. The disease is highly infectious and tends to spread rapidly in an institution. Special precautionary measures should be adopted in all children's hospitals and homes. These include the inspection on admission of the vulva and anal region of every female child under fourteen and a careful watch subsequently for evidence of vaginal discharge. A child with vaginal discharge must be isolated immediately from all other unaffected female children and a specimen from the vagina taken at once for bacteriological examination. All female children in the ward must also be examined clinically without delay and the examination repeated daily. If the original case proves to be gonococcal a bacteriological examination of all the other children in the ward should be made. All admissions to and discharges from the ward should cease till the ward has been declared free from infection for ten days. Special nurses must be assigned to attend the affected children, every affected child must have a separate bed pan, and all infected clothing must be disinfected before being sent to the laundry. Great care should be exercised by nurses in all children's wards—hands should be washed thoroughly after attending to the toilet of each child; children should have separate towels and a separate mackintosh square should be kept for each child to be used when the nurse takes the child on her lap; each child should have its own thermometer, and temperatures should be taken in the mouth or axilla.

W.C. seats should preferably be of the divided pattern and should be carefully cleansed after being used. No infant or child should be allowed, in any circumstances, upon another's cot. Treatment in the past has been most unsatisfactory but recently sulphonamide compounds have been used with considerable success. The whole subject was investigated by a committee appointed by the L.C.C. and was fully reviewed in the *Medical Officer*, 7 and 14 May, 1938, pp. 191, 203, and in the *Brit. J. Ven. Dis.*, 1939, Vol. 15, p. 18. See also *B.M.J.*, 27th May, 1939, p. 1095.

Pemphigus neonatorum is a highly contagious disease occurring usually between the fourth and fourteenth day after birth; it may be of a mild or grave type. Blisters appear on various parts of the body which subsequently burst leaving raw surfaces. Infection may be either direct or indirect. It has often been traced to an attendant midwife suffering from some slight septic condition. No definite pronouncement can at present be made as to the true causal organism, but the *Staphylococcus pyogenes* is known to have been involved in certain outbreaks. Care should be taken not to mistake bullous manifestations of congenital syphilis for those of pemphigus neonatorum. The family history is most important in this connection, and the absence in pemphigus neonatorum of infiltration of the edges of the bullæ and of obvious ulceration until the late stages should help to distinguish the two diseases. Pemphigus neonatorum requires immediate notification to the medical officer of health and all suspicious cases should be reported. If a case is discovered by a health visitor she must advise medical attendance. Any midwife or nurse suspected of being the agent of spread should be suspended from practice at least until an examination has shown that she is free from any sign of infection that can be detected by a thorough medical inspection and until complete disinfection of person, wearing apparel, equipment, etc., has been carried out. (Min. of Health Memo. 103/Med. 1925; *Lancet*, 8th February, 1941, pp. 169–71, Gillespie and Holland.)

Illegitimate children. In 1938 there were 26,379 illegitimate births in England and Wales with an infant mortality rate of 80·78 as compared with 52·68 for legitimate. The illegitimacy rate has risen from 42 per 1,000 births in 1939 to 54 per 1,000 in 1942. An unmarried mother may seek assistance from the local health department. Arrangements can be made easily enough for the confinement, but the subsequent care of the child is a more difficult matter. Homes exist to which such expectant mothers may be admitted and kept for some months after the birth of the baby. Every effort should be made to keep mother and child together as long as possible to enable breast feeding to be undertaken. If the mother cannot herself

look after the baby, the baby may be admitted to a home or be placed in charge of a foster mother. Alimony may be obtained from the father on application to a petty sessional court, and a sum not exceeding 20*s*. a week may be ordered to be paid to the mother for the maintenance and education of the child up to the age of sixteen years. The mother has the custody of the child, and the Registrar of Births may not enter in the register the name of any person as father save at the joint request of father and mother.

By the Legitimacy Act, 1926, an illegitimate child becomes legitimate by the subsequent marriage of its parents if at the time of its birth neither parent was married to a third person, and provision is made for the re-registration of the birth of a legitimated child. A legitimated person may now succeed to property under an intestacy or under a will as if he had been legitimate, and he must maintain all persons he would have been bound to maintain had he been born legitimate.

Adoption of children. The Adoption of Children Act, 1926, provides for the legal adoption of children and permits adoption orders to be made by the High Court, County Court or Court of Summary Jurisdiction. Applicants desirous of adopting a child must be not less than twenty-five years old, and as a rule not less than twenty-one years older than the child. Save in exceptional circumstances, a man may not adopt a female child. The consent of the parents or guardian of the child must be obtained, and the adoption must be in the interests of the child. The order puts an end to all existing rights of the parents and vests them in the adopter, but it does not affect the child's own right to property in respect of its real parents nor give it any rights in respect of the property of the adopter. The Adoption of Children (Regulation) Act, 1939, operative from 1st June, 1943, provides for the registration of adoption societies with county councils and county borough councils and restricts the sending of children for adoption abroad. The prospective adopter must keep the child for three months before an application to adopt is made and the legal formalities must be completed within the following three months. During the whole of this period children are subject to the same sort of protection as are foster-children under the Public Health Act, 1936.

Child life protection. The law relating to this subject will be found in the Public Health Act, 1936, Sections 206–220. Welfare authorities are responsible for the administration.

1. All children under nine years kept for reward apart from their parents, or having no parents, must be notified to the welfare authority. Such children are known as "foster children." The notice must give the name and sex of the

child, the date and place of birth, the name of the person undertaking the maintenance, the dwelling where the child is kept, whether in the daytime or at night, and the name of the person from whom received :—

(*a*) in the case of the first foster child received, not less than seven days before its reception ;
(*b*) in the case of any other foster child, not less than forty-eight hours before its reception ;
(*c*) in the case of a foster child already received without reward, within forty-eight hours after the undertaking to receive for reward.

(It is a defence for the defendant to prove that he received the child upon an emergency and gave notice within twenty-four hours.)

Any change of residence must be notified to the welfare authority at least seven days before removal or, in the case of emergency, within forty-eight hours after. The death of the child or its removal from the care of the foster parent must also be notified within twenty-four hours.

2. Every welfare authority must, if there are any foster children in their area, appoint one or more child protection visitors (usually the health visitors), who must satisfy themselves as to the health and well-being of the children. A justice may grant a warrant to enter suspected premises. A suitable philanthropic institution may be permitted to undertake the duties of these visitors subject to periodical reports, and special premises may be exempt from being visited.

3. Children may be received for reward only with the welfare authority's written sanction in the following cases :—

(*a*) by persons from whose care children have been removed under this Act or the Children Acts ;
(*b*) in premises from which children have been removed by reason of the premises being dangerous or insanitary ;
(*c*) by persons who have been convicted of cruelty to children or of offences under the Children Acts.

4. The welfare authority may fix the maximum number of children under nine years who may be kept in any dwelling in which a foster child is maintained, and may also lay down conditions where the children exceed a specified number.

5. On the complaint of a welfare authority, a court of summary jurisdiction may grant an order for the removal of the child to a place of safety (*i.e.* a remand home, public assistance institution, police station, hospital, surgery or other suitable place). A single justice may issue an order in case of imminent danger to the health or well-being of the child. Such orders may be applied for :—

(*a*) in the case of premises which are overcrowded, insanitary or dangerous;
(*b*) in the case of persons who, by reason of old age, infirmity, ill-health, ignorance, negligence, inebriety, immorality or criminal conduct, or for any other reason, are unfit to have care of the child;
(*c*) in the case of any environment which is detrimental to the child.

6. The coroner must be notified of the death of the child by the person in charge within twenty-four hours, and must hold an inquest unless on receipt of a satisfactory certificate of a duly qualified medical practitioner he decides there is no ground for holding an inquest.

7. No person who keeps a foster child may have an insurable interest in its life; nor may any advertisement be published indicating that a person or society will undertake or arrange for the nursing and maintenance of a child (not confined to children under nine) unless the name and address of the person or society are truly stated in the advertisement.

8. These provisions do not apply to relatives or legal guardians who take children for reward, or to mental defectives under approved care other than institutional. Hospitals, convalescent homes and other accredited institutions are also exempt. Persons to whom children are sent for short holidays by a *bonâ fide* charitable organisation need notify only the first child so received in each year.

9. Persons guilty of offences are liable to imprisonment not exceeding six months or to a fine not exceeding £25, or to both.

An experiment, which has had satisfactory results, has been tried in Birmingham of providing foster mothers through the maternity and child welfare authority. The scheme is designed to prevent the repeated removal of a child from one home to another. Under it the mother of the child applies to the public health department for a foster mother, she is assessed to pay the amount she can reasonably afford and she makes her payments to the department. She is encouraged to keep in touch with the child, remains responsible for its clothing, and a difficulty anticipated at first—that mothers would simply hand over all responsibility to the public health department—has not been found serious in practice. Foster mothers are registered by the department where they receive the payments and it is a condition that the children must be brought regularly to the child welfare centres.

In Dagenham a scheme has been established for day foster mothers instead of day nurseries; the mothers were widely scattered and a single day nursery would have been quite inadequate. The day foster mothers are registered on a panel

and payments are made on similar lines to those of the Birmingham scheme. (*Medical Officer*, 25th Jan., 1941, pp. 29–31, "The Care of Foster Children," Buchan, G. F.)

Under the War Orphans Act, 1942, the Minister of Pensions is responsible for the care of a limited class of war orphans placed by him with foster parents. In these cases supervision is maintained by whole-time officers of the Ministry of Pensions not only whilst the children are under nine years of age, but until the Minister's duty in respect of them under the Act ceases. The Ministry of Pensions is responsible for notifying the local authority of such children and it is unnecessary for child life protection visitors to visit them.

Prevention of Cruelty. Children and Young Persons Act, 1933, Sect. 1. Severe penalties may be inflicted on any person over the age of sixteen years who has the charge of any child or young person under the age of sixteen years and who is guilty of cruelty or neglect in respect of such child or young person. Neglect, likely to cause injury to health, includes failure to provide adequate food, clothing, medical aid or lodging. (Local education authorities are empowered to take action under this section.)

Sect. 11 of the same Act provides that if a child under seven years is killed or suffers serious injury through being burnt or scalded in a room with an open fire-grate not sufficiently protected by a guard, the person in charge shall be liable to a penalty.

The child aged 2–5. While a great deal of attention is paid to the supervision of the health of infants under eighteen months of age, much less is given to the older children ("toddlers") of pre-school age. Children entering school at the age of five years show an unduly large proportion of defects as compared with children at later ages. Three investigations have been carried out by officers of the Ministry of Health and Board of Education, and the results were summarised in the Annual Report of the Chief Medical Officer, Board of Education, 1931, pp. 29–44. The last of these investigations involved a survey of 3,000 children between the ages of two and six years in three representative areas. Approximately 27 per cent. of the children were found to have some physical or mental defect. Over 50 per cent. had never attended an infant welfare centre, and only some 17 per cent. of the children needing it had actually received medical treatment. See table on p. 268, which shows the incidence of the principal defects.

Local authorities have been urged to make provision for the care of these young children where necessary in day nurseries and in nursery schools.

Day nurseries. The power of welfare authorities to provide or to aid the provision of day nurseries for children under five

is given in Section 204 (1) of the Public Health Act, 1936. In 1939 there were about 100 day nurseries in England and Wales, of which twenty were provided by welfare authorities, and the remainder by voluntary bodies, often with assistance from welfare authorities. These nurseries generally admit children of all ages up to five and grants for this work are paid by the Ministry of Health.

All children should be medically examined on admission and a doctor should be on call. Adequate records must be

PERCENTAGE OF PRINCIPAL DEFECTS FOUND IN CHILDREN MEDICALLY EXAMINED.

	Total.	Percentage.
Visited by nurse	3,000	—
Medically examined	809	—
Dental decay—one or more carious teeth	601	74
Rickets (of any degree)	345	43
Adenoids (symptoms)	187	23
Tonsils requiring operation	110	14
Tonsils requiring observation	296	37
Operated on for tonsils and adenoids	96	12
Bronchitis	141	17
Anæmia	158	20
Heart abnormality	99	12
Squint	47	6
Blepharitis	28	3
Otorrhœa	43	5
Rheumatic symptoms	45	6
Feeble-minded	9	—
Imbecile	5	—
Idiot (hydrocephalus)	2	—
Cretin	1	—

(See also Annual Report, Chief Medical Officer, Ministry of Health, 1931, Appendix F., p. 247.)

kept, children should be weighed weekly, there should be a daily examination of the children to detect any signs of infectious disease, and clothing and premises should be disinfected periodically. An adequate diet should be provided, children should be bathed regularly, and should sleep in the open air if possible. Separate towels, flannels and toothbrushes should be kept for each child. There should ordinarily be two nurseries—one for infants and one for toddlers ; other requirements are a small isolation room, daily laundry and storage for soiled garments, milk larder and milk preparation room, staff and kitchen accommodation.

Nursery schools. Section 21 of the Education Act, 1921, empowers local education authorities to provide or to aid the provision of nursery schools for children between the ages of

two and five. In 1939 there were 120 nursery schools in England and Wales recognised by the Board of Education, about half of which were provided by local education authorities, the remainder by voluntary bodies, usually with assistance from education authorities. Grants to local education authorities in respect of this work are paid by the Board of Education, which also pays direct grants to recognised nursery schools conducted by voluntary bodies.

The ideal school is of the open-air type in one storey, with ample ventilation, easy of access to the garden and providing convenient supervision by the staff. Single or "twin" classrooms are better than rooms in series of three or more. Verandahs at least 6 feet wide should connect the different rooms, and should also be placed on at least one side of each room, but not necessarily on the south side. A north verandah is preferable as strong wind and rain come most frequently from the south. The roof of the verandah should be of glass, and there should be a drained concrete floor. It should be possible to open up any side of the room. Doors and windows of the "barn door" type are preferable to the ordinary French window. The floors of the classrooms should be easily washable, and there must be ample cupboard and storage accommodation. The playground should be partly paved and partly grass with flower-beds. Hot and cold water must be provided, and if possible, each group of forty children should have four water-closets, six wash basins, one bath and one cloakroom. Each child should have a peg 30 or 36 inches from the ground, and pegs should be 12 inches apart. There should be a boot-hole under each peg, and there must be provision for drying clothes. Rooms may be warmed either by floor heating, panel heating, radiators or open fires.

These schools must have adequate medical supervision. The children should be selected by the medical staff and should be inspected separately every day by a school nurse. A suitable dietary must be provided, rest and sleep on stretcher beds in the open air should be part of the daily routine; and correct training in habits of cleanliness, of order, of body function, and of speech and sense faculties is essential. (*Medical Officer*, 5th February, 1938, pp. 55–59, Furniss, A.)

War-time Nurseries. The outbreak of war in September, 1939, led to the closure of many of the peace-time day nurseries and nursery schools. About 100 of those situated in the large towns were evacuated as units to the country under the Government Evacuation Scheme and have since been conducted as residential nurseries. In addition, other residential nurseries for evacuated children under five have been specially established by local education authorities, welfare authorities, and voluntary societies such as the Waifs and Strays Society, the

Anglo-American Relief Fund, the "Save the Children" Fund and Priestley Nurseries. In March, 1943, the number of residential nurseries for evacuated children had risen to over 400.

In the industrial areas the numbers of day nurseries and nursery schools remained small from the outbreak of war until early in 1941, when the influx of women into industry led to the introduction by the Ministry of Health and the Board of Education of the War-time Nurseries Scheme, under which welfare authorities were authorised to provide, at the expense of the Exchequer, nurseries for young children of women in employment. These war-time nurseries usually admit children of all ages up to five and are organised on the lines of peace-time day nurseries with a matron in charge. The local education authority assists on the educational side and a warden (or teacher) is appointed for the instruction of the children between two and five on nursery school principles. War-time nurseries are open for such daily hours as local industrial conditions may require—often for twelve hours a day or more. The nurseries are housed in adapted premises or in prefabricated hutments supplied by the Government, the necessary equipment being provided from a central "pool" set up by the Ministry of Health. Trained and competent staff is essential. Besides the matron, who should preferably be a trained nurse, and warden, the staff may consist of nursery nurses, nursery assistants, girl helpers and domestics. The Child Care Reserve Scheme, established by the National Council for Maternity and Child Welfare, provides short courses of training for wardens and nursery assistants in the nurseries, these courses being conducted by local education authorities.

In addition to the war-time nurseries established by welfare authorities, local education authorities have been encouraged to set up war-time nursery classes in elementary schools wherever accommodation permits, these classes fulfilling the same function of providing for children of women in employment, though their age range is limited to children between two and five. On 31st March, 1943, there were in operation in England and Wales 1,232 war-time nurseries accommodating 52,500 children, together with 569 war-time nursery classes accommodating 21,000 children. (See *Public Health*, June, 1943, p. 104, Hartley, Greta.)

THE SCHOOL MEDICAL SERVICE

The central authority for education is the Board of Education. County councils, county borough councils and the larger municipal borough and urban district councils are the local education authorities for elementary education, while county councils and county borough councils are the local education

authorities for higher education (secondary schools, technical schools, continuation schools). The Board of Education pay grants up to one-half of the approved net expenditure on special services, *i.e.* school medical service, provision of meals, special schools, organisation of physical training in elementary schools, play centres and nursery schools. (Elementary Education (Substantive Grant) Regulations, 1930.)

Education Acts, 1921 to 1937

1. The parents of every child between the ages of five and fourteen must cause that child to receive efficient elementary education. (The Education Act, 1936, raised the school-leaving age to fifteen, but exemption may be granted on certain grounds.)

"Child" means a child of any age up to the age when his parents cease to be under an obligation to cause him to attend school and includes a child of any age who is attending a public elementary school.

2. Local education authorities for elementary education must ascertain what children within their areas are so blind, deaf, defective or epileptic as to be incapable of receiving proper benefit from the instruction in the ordinary public elementary schools, but are not incapable by reason of that defect of receiving benefit from instruction in special classes or schools certified as suitable by the Board of Education. Education must be provided for such children between the ages of seven and sixteen in special certified classes or schools. The Education (Deaf Children) Act, 1937, provides that the fact of a child under seven being deaf shall not of itself be a reasonable excuse for not causing the child to attend school.

3. Local education authorities for elementary education must make adequate and suitable arrangements for the medical inspection and treatment of children attending public elementary schools.

Local education authorities for higher education must provide for the medical inspection of scholars attending secondary schools and continuation schools. The provision of treatment is optional.

Parents are required to contribute towards the cost of any medical treatment provided, and, save in necessitous cases, the sum is recoverable as a civil debt.

4. Meals may be provided for elementary school children both on days when the school meets and on other days. A charge must be made save in necessitous cases.

5. Nursery schools may be established for children over two and under five years of age whose attendance at such schools is necessary or desirable for their healthy physical and mental development.

6. Powers are given to aid or maintain holiday camps, playing fields, school swimming baths, and physical training centres.

7. A local education authority for elementary education may direct their medical officer, or any person (usually the school nurse) provided with the written authority of their medical officer, to examine the person and clothing of any child in any public elementary school. If the person or clothing of any such child is found to be verminous or filthy, the local education authority may give notice in writing to the parent requiring him to cleanse the child within twenty-four hours. The notice must be accompanied by instructions describing the manner in which cleansing may best be effected. In default, a person provided with the written authority of the medical officer may remove the child from school and have the cleansing done in some suitable place. If the parent allows the child to become verminous or filthy again, he is liable to a fine not exceeding ten shillings. Local authorities, if they possess or have the right to use premises for cleansing, must allow such premises to be used by the education authority. Girls must be examined and cleansed either by a medical practitioner or by a specially authorised woman.

8. Legal proceedings may be taken under section one of the Children and Young Persons Act, 1933, by the local education authority in cases of persistent neglect of children (such neglect includes failure to provide adequate food, clothing, lodging or medical aid).

Considerable changes are foreshadowed in the Government White Paper on "Educational Reconstruction," July, 1943, and in the Education Bill at present under discussion in Parliament.

It is proposed that in future the local education authorities shall be the councils of the counties and county boroughs only, with combinations of these in certain cases. County authorities will be required to establish district education committees. For this purpose a county will be divided into areas, each area consisting of one or more county districts, provided that any county district with a minimum total population of 60,000, or a minimum elementary school population of 7,000 children, will have the right to have a separate district committee for its area. Important functions may be delegated to these committees by the county education committee.

It is intended that the school-leaving age will be raised to fifteen as soon as possible after the war without exemptions, and that provision should be made for a further extension to sixteen at a later date.

Local education authorities will be given the duty of pro-

viding or aiding the supply of nursery schools for children between the ages of two and five.

All young persons from fifteen to eighteen will be required to attend part-time an appropriate training centre or "young people's college."

It is proposed to make it the duty of local education authorities to provide for the medical inspection of all children and young persons attending grant-aided schools and to take such steps as may be necessary to ensure that those found to be in need of treatment, other than domiciliary treatment, shall receive it. The present power of local education authorities to provide school milk and meals will become a duty, and they will also be empowered to supply clothing and footwear for children and young persons, with certain provisions for the recovery of costs.

Appointment and duties of a School Medical Officer. The school M.O. was first recognised in the Code of Regulations for Public Elementary Schools, 1908, as an officer having specific functions in the system of public elementary education. The Board of Education (Special Services) Regulations, 1925, require a local authority to appoint a school medical officer and such other medical officers, nurses and other persons as are necessary. The name of any person whose appointment as school medical officer is proposed must be submitted to the Board of Education for approval before his appointment. In addition to the general medical supervision of the children attending public elementary and secondary schools in his area, the duties of a school medical officer include :—

1. Reporting on the working and effect of any arrangements made for educating children at open-air schools, school camps, or other places selected with a view to the improvement of the health and physical condition of the children.
2. Advising or approving school closure.
3. Authorising the exclusion of certain children from school.

The Board of Education desires to concentrate and organise in the department of the school M.O. all matters of school hygiene. It is for this reason that the M.O.H. and school M.O. are usually one and the same official.

Other matters he must advise on are—

1. Suitability of school premises.
2. Effect of desks and benches on posture.
3. Eyestrain as affected by lighting, size of type in school books, fine sewing, etc.
4. Schemes of physical exercises, with special regard to weakly children.
5. Personal hygiene.

The school M.O. should be consulted in regard to the conduct of the teaching of hygiene, and he may give advice and

assistance in the training of the teacher for this educational work.

6. Mentally and physically defective children.

7. Provision of school meals.

When he himself is not the M.O.H. of the district he must co-operate with the local authority, and give all information possible regarding cleanliness, necessity for disinfection, prevalence of infectious disease, etc. Finally he is expected to advise parents regarding the desirability of obtaining treatment for any defects discovered in the children.

The school M.O. must report annually to the local education authority, and copies of the report must be sent to the Board of Education. If the M.O.H. is also school M.O., this report is usually included in his ordinary annual report.

The report should deal with the following matters :—

(*a*) General conditions of school premises from the health standpoint.

(*b*) Methods of medical inspection adopted.

(*c*) Extent and scope of medical inspection.

(*d*) Conditions revealed by inspection.

(*e*) Means of treatment available.

(*f*) Infectious disease, and methods of prevention and detection.

(*g*) Physically and mentally defective children.

(*h*) Instruction in personal hygiene, physical exercises, open-air schools, etc.

(*i*) Employment of children and young persons.

Medical inspection of school children (Board of Education (Special Services) Regulations, 1925). 1. Children attending public elementary schools must be inspected as soon as possible in the twelve months following—

(*a*) their first admission to school;
(*b*) their attaining the age of eight years;
(*c*) their attaining the age of twelve years.

2. Scholars under the age of eighteen years attending places of higher education provided by the authority (secondary schools, continuation schools, pupil teacher centres, technical schools) must be inspected—

(*a*) during the first term after their admission to the school or institution;
(*b*) in each subsequent year of their age during the period of their attendance.

Children under twelve need not be inspected annually, nor need young persons over seventeen be inspected.

(A complete examination should be made at age eleven or twelve and again at fifteen years. In the other years " it is sufficient for all pupils to come under medical supervision.")

3. Children attending special schools should be inspected once every six months.

The accompanying schedule, issued by the Board of Education, constitutes the minimum of efficient medical inspection. It is intended as a guide to local authorities.

NOTES FOR INSPECTING OFFICER

Ref. No.

1. Date of birth to be stated exactly, date of month and year.
2. "Other illnesses" should include any other serious disorder which must be taken into account as affecting, directly or indirectly, the health of the child in after-life, *e.g.* rheumatism, tuberculosis, congenital syphilis, smallpox, enteric fever, meningitis, fits, mumps, etc. The effects of these, if still traceable, should be recorded.
3. State if any cases of, or deaths from, phthisis, etc., in family.
4. Note backwardness.
5. Age to be stated in years and months, thus, $5\frac{4}{12}$.
6. Insufficiency, need of repair, and uncleanliness should be recorded (good, average, bad).
7. Without boots, standing erect with feet together, and the weight thrown on heels and not on toes, or outside of feet.
8. Without boots, otherwise ordinary indoor clothes. Height and weight may be recorded in English measures if preferred. In annual report, however, the final averages should be recorded in both English and metric measures.
9. General nutrition as distinct from muscular development or physique as such. State whether excellent, normal, slightly subnormal, or bad. Under-nourishment is the point to determine. Appearance of skin and hair, expression, and redness or pallor of mucous membranes are among the indications. (See *Administrative Memorandum No.* 124, December, 1934, on "Statistical Returns relating to Nutrition.")
10. Cleanliness may be stated generally as clean, somewhat dirty, dirty. It must be judged for head and body separately. The skin of the body should be examined for cleanliness, vermin, etc.; and the hair for scurf, nits, vermin, or sores. At the same time ringworm and other skin diseases should be looked for.
11. General condition and cleanliness of temporary and permanent teeth, and amount of decay. Exceptional features, such as Hutchinsonian teeth, should be noted. Oral sepsis.
12. The presence or absence of obstruction in the naso-pharynx is the chief point to note. Observation should include mouth-breathing; inflammation, enlargement, or suppuration of tonsils; probable or obvious presence of adenoids, polypi; specific or other nasal discharge, catarrh, malformation (palate), etc.
13. Including blepharitis, conjunctivitis, diseases of cornea and lens, muscular defects (squints, nystagmus, twitchings), etc.
14. To be tested by Snellen's Test Types at 20 feet distance (= 6 metres). Result to be recorded in the usual way, *e.g.* normal V. = $\frac{6}{6}$. Examination of each eye (R. and L.) should, as a rule, be undertaken separately. If the V. be worse than $\frac{6}{9}$, or if there be signs of eyestrain or headache, fuller examination should be made subsequently. *Omit vision testing of children under six years of age.*
15. Including suppuration, obstruction, etc.
16. If hearing be abnormal, or such as interferes with class work, subsequent examination of each ear should be undertaken

Ref. No.

separately. *Apply tests only in general way in case of children under six years of age.*

17. Including defects of articulation, lisping, stammering, etc.
18. Including attention, response, signs of overstrain, etc.

    The general intelligence may be recorded under the following heads: (*a*) Bright, fair, dull, backward; (*b*) mentally defective; (*c*) imbecile. *Omit testing mental capacity of children under six years of age.*
19. Under the following headings should be inserted particulars of diseased conditions actually present or signs of incipient disease. The extent of this part of the inspection will largely depend upon the findings under previous headings.
20. Include heart sounds, position of apex beat, anæmia, etc., in case of anything abnormal or requiring modification of school conditions or exercises.
21. Including physical and clinical signs and symptoms.
22. Including chorea, epilepsy, paralyses and nervous strains and disorders.
23. Glandular, osseous, pulmonary, or other forms.
24. State particular form, especially in younger children.
25. Including defects and deformities of head, trunk, limbs. Spinal curvature, bone disease, deformed chest, shortened limbs, etc.
26. Including any present infectious, parasitical or contagious disease, or any sequelæ existing. At each inspection the occurrence of any such diseases since last inspection should be noted.
27. Any weakness, defect or disease not included above (*e.g.* ruptures) specially unfitting child for ordinary school life or physical drill, or requiring either exemption from special branches of instruction or particular supervision.

A child should be referred for refraction if he fails to read $\frac{6}{12}$ (Snellen) by the worse eye at a distance of 20 feet. A child with an error of $\frac{6}{9}$ in both eyes may be referred if symptoms such as headaches are associated with the defect. (For standards of vision see Annual Report for 1923 of the Chief Medical Officer of the Board of Education, p. 26. In the Ministry of Health Circular 1520, dated 21 January, 1936, a standard of illumination of not less than 10 foot-candles is suggested for all test types.) Hypermetropia is common in younger children, myopia in older. Astigmatism is a common cause of headache. Squint is often associated with hypermetropia, and a squinting eye in time may become blind through lack of use. Bad school arrangements may be responsible for eyestrain—*e.g.* insufficient light, light from a wrong direction, badly lighted blackboards, fine sewing and too small print in text-books. Bad home conditions, of course, render the child more prone to suffer. Colour vision is not ordinarily tested, but it may be noted that an investigation in Lancashire in 1933 showed that 4·3 per cent. of boys and 0·6 per cent. of girls in elementary schools suffered from colour blindness in varying degree, the commonest type being "red-green" blindness.

Hearing is usually tested either by forced expiratory whisper or by spoken voice at a distance of 20 feet, each ear being

SCHEDULE OF MEDICAL INSPECTION

I.—Name ______________________ Date of Birth[1] ______________________

Address ______________________ School ______________________

II.—Personal History—

(a) Previous Illnesses of Child (before admission).

Measles	Whooping Cough.	Chickenpox.	Scarlet Fever.	Diphtheria.	Other Illnesses.[2]

(b) Family Medical History (if exceptional)[3]

—	I.	II.	III.	IV.	—	I.	II.	III.	IV.
1. Date of Inspection					13. Ear disease[15]				
2. Standard and Regularity of Attendance[4]					14. Hearing[16]				
3. Age of Child[5]					15. Speech[17]				
4. Clothing and foot gear[6]					16. Mental condition[18]				
III.—*General Conditions.*					V.—*Disease or Deformity.*[19]				
5. Height[7]					17. Heart and circulation[20]				
6. Weight[8]					18. Lungs[21]				
7. Nutrition[9]					19. Nervous system[22]				
8. Cleanliness and condition of skin[10]					20. Tuberculosis[23]				
Head					21. Rickets[24]				
Body					22. Deformities, Spinal Disease, etc.[25]				
IV.—*Special Conditions.*					23. Infectious or contagious disease[26]				
9. Teeth[11]					24. Other disease or defect[27]				
10. Nose and throat[12]									
Tonsils									
Adenoids									
Submaxillary and cervical glands									
11. External eye disease[13]									
12. Vision[14]									
R.					Medical Officer's initials				
L.									

General Observations

Directions to Parent or Teacher

examined separately, but increasing use is being made of the gramophone audiometer (p. 295). (See Annual Report, Chief Medical Officer, Board of Education, 1931, pp. 71–81—defective vision and hearing.)

In 1938 school dentists found that 70 per cent. of the children they inspected required treatment, and of those recommended for treatment 65·5 per cent. actually obtained treatment.

In 1935 the term "malnutrition" was omitted from the return required by the Board of Education, and school medical officers were required to classify children in four groups, according to their nutritional state: A (excellent), B (normal), C (slightly subnormal) and D (bad). This classification has been continued and must be made on clinical grounds (see Ann. Rep., C.M.O., Bd. of Ed., 1937, p. 19). It must not be based solely on the height and weight of the child. Attention must be paid to the general appearance, facies, carriage, posture, the condition of the mucous membranes, the tone and functioning of the muscular system and the amount of subcutaneous fat. During 1938 the nutrition of 1,674,023 children examined at routine medical inspections was assessed—14·5 per cent. were placed in A, 74·2 per cent. in B, 10·8 per cent. in C and 0·5 per cent. in D. The age-group eight to nine years showed the poorest figures in almost all areas. Information on other methods of assessing the nutritional state will be found in the *Quarterly Bulletin of the Health Organisation of the League of Nations* (Vol. IV., No. 2, June, 1935), in the *Medical Officer*, 6th March, 1937, p. 97, and in *J. Roy. San. Inst.*, July, 1941, pp. 147–154, Cowan, K.

Special inspections are inspections (1) of children referred by the school M.O. himself for a more detailed examination than can be given at routine inspection, and (2) of children referred by head teachers, attendance officers, etc. These special inspections may be made on school premises or at the school clinic.

The table on p. 279 shows some of the results of medical inspection for 1938.

Children attending secondary schools show fewer physical defects than do elementary school children, save in respect of defects of vision at age fourteen and upwards and of postural defects. Both these defects are probably the result of more intensive study. (A general discussion on the school medical service will be found in the *J. Roy. San. Inst.*, September, 1935. pp. 96–116, and in the Annual Report, Chief Medical Officer, Board of Education, 1935, pp. 65–72.)

Treatment of school children. Exclusive of those showing dental defects and uncleanliness, about 18 per cent. of children inspected on a routine basis require treatment.

The local education authority should arrange for—

1. An adequate scheme of medical inspection and diagnosis.
2. An adequate system of school nursing.
3. Establishment of school clinics (medical, surgical and dental).
4. Treatment of school children at hospitals, when the private practitioner and the school clinic are unavailable or inappropriate.
5. The supply of spectacles, gratuitously or at a reduced rate.
6. Remedial treatment centres for physical deformities.
7. Special schools or classes for blind, deaf, dumb, feeble-minded, epileptic, tuberculous, crippled or debilitated children requiring institutional treatment.

	Routine Inspections (1,677,308).		Special Inspections (1,563,917).	Total No. of Defects.
	No. of Defects requiring Treatment.	Incidence per 1,000 Inspections.	No. of Defects.	
Skin Diseases	17,612	10·5	231,892	249,504
Defects of Vision	83,640	74·0 *	71,294	154,934
Squint	13,663	8·1	13,636	27,299
Other Eye Diseases	10,751	6·4	51,217	61,968
Defects of Hearing	4,805	2·9	6,712	11,517
Otitis Media	6,689	4·0	25,686	32,375
Chronic Tonsillitis	34,334	20·5	21,110	55,444
Adenoids	4,546	2·7	3,446	7,992
Adenoids and Chronic Tonsillitis	33,484	20·0	31,485	64,969
Other Nose and Throat Defects	11,274	6·7	44,261	55,535
Defects of Speech	2,451	1·5	2,280	4,731
Organic Heart Disease	2,750	1·6	2,745	5,495
Pulmonary Tuberculosis :				
(*a*) Definite	122	0·1	358	480
(*b*) Suspected	617	0·4	1,762	2,379
Non - Pulmonary Tuberculosis	804	0·5	1,492	2,296
Epilepsy	403	0·2	876	1,279
Chorea	700	0·4	3,308	4,008
Other Nervous Conditions	2,448	1·5	4,149	6,597
Deformities :				
Rickets	1,890	1·1	1,249	3,139
Spinal Curvature	4,757	2·8	2,424	7,181
Other Forms	17,116	10·2	12,603	29,719

* This figure is based on the number of routine inspections, excluding entrants, as the vision of infants is not usually tested.

Under the Board of Education (Special Services) Regulations.

1925, local education authorities for elementary education *must* arrange for—

(*a*) the following up of cases of defect found in the course of medical inspection.
(*b*) the detection and prevention of uncleanliness.
(*c*) the medical treatment of defects of the eyes and teeth, minor ailments, and enlarged tonsils and adenoids.

The treatment of ringworm of the scalp by X-rays should be provided; and some form of orthopædic treatment. The consent of parents must always be obtained before any treatment is given. "Following up" is done by the school nurses. Under the treatment scheme of the London County Council the calculated full cost of treatment per case during 1939 was approximately: enlarged tonsils and adenoids, 21*s.*; minor ailments, 6*s.*; dental treatment, 9*s.*; X-ray treatment for ringworm, 47*s.* 6*d.* The charges ordinarily made to parents varied from 1*s.* to 5*s.*, according to the type of treatment required.

The *school clinic* serves three purposes—(1) medical inspection of special cases, (2) treatment centre and (3) administrative centre.

The most approved practice is to combine the school clinic with other health activities of the local authority in what is called a health centre or health clinic. The plan of a health clinic designed by the Ministry of Health will be found on pp. 260 and 261 (see also Annual Report, Chief Medical Officer, Board of Education, 1923, p. 177, "The Equipment of the School Clinic").

Minor ailments include such defects and diseases as can properly be treated in a school clinic by simple treatment and careful nursing, *e.g.* ringworm of the body, scabies, impetigo (Annual Report, Chief Medical Officer, Board of Education, 1928, p. 127; *Lancet*, 1st May, 1943, pp. 544–7, Bigger, J. W., and Hodgson, G. A.; also pp. 547–50, Sheehan, H. L., and Fergusson, A. G.), cuts, septic spots, minor eye and ear defects. The work is done by a school nurse under the general supervision of a medical officer.

Ringworm (Annual Reports, Chief Medical Officer, Board of Education, 1927, Appendix C, p. 166, and 1933, p. 88). The incidence of ringworm of the scalp, which has declined greatly in the last twenty years, was 4 per 1,000 average attendance in England and Wales, during 1926–27. It was highest in north-eastern districts. It is lower in districts where X-ray treatment is provided than in areas where no such provision exists. In 1937 the number of children treated under local authorities' schemes was 0·6 per 1,000 average attendance. Twenty-five years ago over 10,000 cases of ringworm were dealt with annually under the London County Council's scheme, in 1921 the

number was 1,913, whereas during 1938 it was only 103 (see also p. 136).

Ear disease (Annual Report, Chief Medical Officer, Board of Education, 1923, pp. 36–42, and Annual Report of the School Medical Officer, London County Council, 1934, pp. 24–28). During 1938 the number of cases of otorrhœa requiring treatment per 1,000 routine inspections in England and Wales was 4. In London the percentage of children found at routine inspection to be suffering from this condition fell from 3·7 in 1911 to 0·7 in 1938. The main causes are enlarged tonsils and adenoids and infections such as scarlet fever and measles. Zinc ionisation usually secures rapid cure of cases of simple tympanic sepsis. Mastoid operation is still necessary for certain chronic cases, with foul discharge and involvement of the mastoid cells (see also pp. 294, 346).

Adenoids and enlarged tonsils. An excellent summary is to be found in the Annual Report of the Chief Medical Officer, Board of Education, 1931, pp. 50-64. In England and Wales in 1931 the proportion of children dealt with by operation was 2·2 per cent. of average attendance in elementary schools, and varied according to areas from 1 per cent. to as high as 8·5 per cent. Of recent years, however, fewer children have been submitted to operation (see also Ann. Rep., C.M.O., Bd. of Ed., 1937, p. 69). The conditions of a satisfactory scheme for operative treatment are laid down in the Annual Report of the Chief Medical Officer, Board of Education, 1923, p. 29. The scheme should be under the control of the school medical officer, who should satisfy himself that operative treatment is in fact needed in each case. The main indications for operation are :—

(*a*) Ear complication, deafness.

(*b*) Hypertrophic *rhinitis, mouth breathing, obstructed* respiration.

(*c*) Recurring tonsillitis or tonsillar abscess.

(*d*) " Adenoid facies," " adenoid voice."

(*e*) Recurrent catarrh, asthma or septic infection.

(*f*) Retardation of physical and mental growth.

(*g*) Enlarged cervical glands.

The operation should be performed in hospital, and children should be detained for forty-eight hours afterwards. Printed instructions should be given the parents regarding preparation of the child for the operation as well as regarding after-care (which should include breathing exercises). A school nurse should visit the home before and after the operation. In certain areas the operation is still performed at a clinic and the children sent home the same day. Such a practice should, however, be discouraged. (The incidence of tonsillectomy in school children is well discussed by J. A. Glover in *Proc. Roy.*

Soc. Med., Sect. Epidem., State Medicine, Vol. XXXI., No. 7, August, 1938, p. 1219, and *Medical Officer*, 9th March, 1940, p. 85, Garrow, R. P.)

Ophthalmic treatment (Annual Report of the Chief Medical Officer, Board of Education, 1934, pp. 65–76). Nine per cent. of children examined (exclusive of entrants) show some defect of vision, including squint. It is advisable that a school medical officer should make " vision surveys " in his area, as otherwise children will have to wait till the time of routine inspection before any defects are discovered. This is important in the infant department, as at present the vision of children under seven years of age is not examined at routine medical inspection. Bishop Harman has shown that among 368 infants attending a good-class elementary school no fewer than 36·9 per cent. had defects of the eyes and 16 per cent. considerable defect. It is likely that the correction of gross defects at an early age would tend to check much of the myopia which develops in later years. The burden of detecting serious defects of infants' eyes rests with the teachers, who should refer for examination infants who squint, whose eyes get irritable after work, who fail to see marks on the blackboard, and even those who appear dull and stupid in general class lessons. Refraction work should be done only by experienced oculists, and arrangements should be made to have the prescribed spectacles fitted by a skilled optician, who may attend at the school or clinic for the purpose. Care committees often assist parents to pay for spectacles.

External eye diseases consist mainly of conjunctivitis, blepharitis, corneal opacities and keratitis. Their importance and the best methods of dealing with them are discussed in the Annual Report, Chief Medical Officer, Board of Education, 1929, pp. 104–110. The problem of trachoma is well reviewed by Mackenzie in the Epidemiological Report of the League of Nations, No. 46 (April-June), 1935. Concomitant squint and its treatment (including orthoptic treatment) is the subject of an article by L. H. Savin in *The Lancet*, 8 September, 1934, p. 523 (see also Ann. Rep., C.M.O., Bd. of Ed., 1937, p. 89).

Dental scheme (Annual Reports, Chief Medical Officer, Board of Education, 1932, p. 151, and 1933, p. 164). The scheme should be under the control of the school medical officer and dental inspection should be carried out by a dentist on school premises and during school hours. Each child should be inspected as an entrant and should be re-examined each year of his school life. Treatment should be offered when necessary. It is better to arrange for the adequate inspection and treatment of a limited number of children than to attempt to deal with a larger number by spacing out inspections. Accurate records should be kept of each mouth examined and treated. Treatment should be conservative and simple orthodontic

work may be undertaken. A school nurse or other capable attendant should assist the dentist during treatment sessions, and anæsthetics should be given by a medical man or by a second dentist. The use of ethyl chloride as a general anæsthetic in school dentistry is undesirable. Adequate provision for the dentist should be made in the school clinic—waiting-room, operating-room, rinsing or recovery room. Educational work on dental hygiene should also be undertaken and the scheme should be co-ordinated with those for maternity and child welfare, tuberculosis, etc. The Board of Education estimate that there should be one dentist for 5,000 children in an urban area and for 4,000 in a rural area, although this standard will be insufficient where a high percentage of parents accept treatment for their children.

In 1938 well over three million children were inspected by dentists, 70 per cent. of those inspected were referred for treatment and the number actually treated was 65·5 per cent. of those referred.

The question of the distribution of endemic human fluorosis ("mottled enamel") is now receiving considerable attention both in this country and in the U.S.A. The continuous use of water containing a concentration of 1 part per million of fluorine will produce mottled enamel for which there is no cure. Apart from this it has been shown that in areas where fluorine is known to be present the inhabitants show a relative immunity to dental caries. The resultant permanent disfigurement produced by mottled enamel far outweighs any advantage that might accrue from the standpoint of partial control of dental caries. Relative immunity to caries can be produced by the continued use of waters of low fluorine content (*Lancet*, 15th February, 1941, pp. 211–12, Wilson, D. C.; *U.S.P.H.S. Report*, Vol. 56, No. 9, 28 February, 1941, pp. 365–381, Dean, H. T., and others).

Uncleanliness. In 1938 school nurses made nearly 15 million examinations of children for the detection of uncleanliness and found 444,967 children unclean. Legal proceedings were taken by local education authorities in 911 cases. In spite of these figures, great improvement has taken place in the last twenty-five years. In London in 1913 only 67·2 per cent. of the older girls at routine medical inspection were completely free from vermin in the hair; in 1938 the figure for eleven-year-old girls was 97·1 per cent. The school nurse should inspect each child as soon as can be arranged after its admission to school. All children should be examined not less frequently than once a term and all dirty children every week. Parents may not refuse to have their children so examined (Fox *v.* Burgess, King's Bench Division, 1922) as they probably may in the case of routine medical inspection. The procedure for dealing

with persistently verminous children is set out in the Education Act, 1921 (see p. 272). When a local education authority, for some reason or other, are unable to take action under the Education Act, an unclean child may be excluded from school and proceedings subsequently taken against the parent, under the school attendance bylaws, for non-attendance of the child at school. The use of various patterns of metal "nit combs" has made cleansing of girls' hair a much simpler matter (see p. 192).

Provision of meals (Annual Reports, Chief Medical Officer, Board of Education, 1929, Appendix F, pp. 111–116; 1931, pp. 107–110). The Education Act, 1921, enables local authorities for elementary education to provide meals for children attending school both on days when the school meets and on other days. During the war the provision of milk in schools and of school meals has been encouraged in every way possible by the Board of Education and by the Ministry of Food. Government grants are available to meet the total cost of kitchen and canteen equipment and the usual grant of 50 per cent. is allowed towards the remaining expenditure on this service. In May, 1943, the number of elementary school children receiving milk ($\frac{1}{3}$–$\frac{2}{3}$ pint daily) either free or at reduced cost under the scheme on one day was 3,179,347. This represented 78·1 per cent. of all the children in attendance. The number who received the milk free was 284,514 which represented 7 per cent. of the number in attendance. At the same time 912,000 children (22·4 per cent. of those in attendance) were receiving mid-day meals free or at reduced cost. In addition, in the secondary schools approximately 291,000 children were receiving milk and approximately 222,000 were receiving mid-day meals free or at reduced cost.

Physical education. The Medical Department of the Board of Education bases a national scheme of physical education on the following :—

(*a*) A syllabus of physical education for all elementary schools, by means of which reasonable uniformity may be secured. A combination of Swedish exercises with organised games for the playground and the playing field, athletics, swimming wherever possible, dancing and other activities where suitable teaching is available.

(*b*) Training in physical exercises for all students attending training colleges, as well as special holiday courses, etc., for teachers.

(*c*) Appointment of physical training organisers to act as advisers and demonstrators.

(*d*) Reasonable facilities (including sufficient time) and equipment for games, play, dancing, swimming, as well as for the more formal gymnastic exercises.

It is advised that a daily lesson of not less than twenty minutes should be given. Organised games should also be arranged. The exercises should be taken, if possible, in a properly ventilated playground shed. Classrooms are unsatisfactory. Assistance may be given to the scholars to provide shoes, and cheap and simple tunics can be made by the girls in their needlework classes. Folk and country dances are being more and more taught to girls, with good results. Instruction in swimming is becoming more general. In certain instances the local education authority have provided swimming baths. In most cases arrangements are made for the admission of the children to public baths at special times. School shower-baths are found in some districts where children are unable to have suitable bathing in their own homes. Evening play-centres are available in certain areas, the school premises are often used for table games and useful occupations of all sorts, and organised games are also played in the playground. Paid helpers are necessary and voluntary assistance is desirable. Under the Physical Training and Recreation Act, 1937, local education authorities for higher education are given power to extend schemes for the promotion of social and physical training to persons of any age. (See Board of Education, Syllabus of Physical Training for Schools, 1933; Annual Reports, Chief Medical Officer, Board of Education, 1932, pp. 92–99, where a useful note on the posture of school children will be found, and 1933, pp. 32–58; also Board of Education Circulars 1486, November, 1939, and 1503, March, 1940).

The teaching of hygiene in schools. The Board of Education's "Handbook of Suggestions on Health Education," 1939, gives an excellent outline of the subject. The study and practice of health should form, from the first, part of the everyday life of the school. Hygiene should be taught systematically at least once a week, and the instruction should be given as a rule by the school teacher. The subject is well reviewed in the Annual Reports of the Chief Medical Officer, Board of Education, 1929, pp. 37–55, and 1932, pp. 100–110.

Medical supervision of employed children. Under Part II. of the Children and Young Persons Act, 1933, no child may be employed :—

(*a*) under twelve years of age ;
(*b*) before the close of school hours on any school day ;
(*c*) before 6 a.m. or after 8 p.m. on any day ;
(*d*) for more than two hours on any school day ;
(*e*) for more than two hours on any Sunday ;
(*f*) to lift, carry or move anything so heavy as to be likely to injure him.

A local education authority may make bylaws :—

1. authorising the employment of children under twelve by

their parents or guardians in light agricultural or horticultural work;

2. authorising the employment of children for not more than one hour before the commencement of school hours on any school day;

3. prohibiting absolutely the employment of children in any specified occupation;

4. prescribing—

(a) the age below which children are not to be employed;

(b) the number of hours in each day for which and the times of day at which they may be employed;

(c) the intervals for meals and rest;

(d) the holidays or half-holidays;

(e) any other conditions to be observed.

The Act also contains special provisions applicable to children taking part in entertainments and forbids the employment of persons under sixteen in street trading, though a bylaw may permit street trading in the case of young persons under sixteen employed by their parents.

It should be noted that no child may be employed in any factory or workshop, mine or quarry.

In Bradford in 1938 (average attendance 36,208) some 700 children were employed out of school hours mainly as errand boys and girls; all children desirous of taking part in public entertainments were medically inspected, and it is interesting that such employment appeared rather to benefit the children than otherwise. Each child, before leaving school, is provided with a juvenile employment card containing particulars of his physical condition, and the Juvenile Employment Bureau co-operates actively with the school medical service in its endeavour to place children in employment. Bradford is divided into eighteen districts, each of which is served by an after-care committee of voluntary workers. Junior instruction centres are provided for boys and girls, and juveniles claiming unemployment insurance benefits have to attend courses of instruction, where available, for five hours a day on five days a week, half of the time being devoted to handicraft and half to general education, physical training, games and swimming. (See Annual Report, Chief Medical Officer, Board of Education, 1933, pp. 151–158.)

The employment of children and young persons is dealt with also in the Shops Act, 1934, the Factories Act, 1937, the Young Persons (Employment) Act, 1938, and various Orders and Regulations (see pp. 667, 672). The hours of employment of children under sixteen are restricted to 44 per week and of young persons aged sixteen to eighteen to 48 per week. In cases of special urgency overtime is permitted for the latter group, but the number of hours is restricted.

Infectious disease among school children

(Memorandum on closure of and exclusion from school, Ministry of Health and Board of Education, 1942.)

If, during epidemics of infectious disease, the power to exclude individual children from school be used to the best advantage, it is only in special and quite exceptional circumstances that it will be necessary to close a school in the interests of public health. Exceptional circumstances include—

(*a*) infectious disease in the teacher's family involving risk to scholars;

(*b*) disinfection and cleansing after infectious disease, if such procedure cannot be carried out during the night or week-end;

(*c*) the rectification of sanitary defects.

In rural areas with a scattered population the closure of isolated schools with a very small attendance may occasionally aid in preventing the spread of disease owing to the fact that the children from different households have fewer opportunities for intercourse elsewhere than at school. As a general rule closure is not justified in any case unless (*a*) evidence points to the continued meeting of the children in school as a source of infection; (*b*) cases of infectious disease continue to occur after every effort has been made to discover the infecting cause; and (*c*) there is good reason to expect that closure will considerably reduce the likelihood of exposure to infection. Closure need not extend to the whole school or a whole department. It may on suitable occasions be limited to a particular class, but this does not constitute school closure as understood in the "Code." Playgrounds should not remain open when schools are closed, and an endeavour should be made to obtain closure of Sunday schools as well. School closure should be reported to the Minister of Health.

Individual children must be excluded from school until there is reason to believe that they have ceased to be in an infectious condition and until all necessary disinfection has been carried out. When exclusion of individual children fails to arrest the spread of infection, it is usually due to the continued attendance at school of mild or unrecognised cases. Such cases should be sought for especially among (*a*) children attending school from the same street or vicinity as the recognised patients; (*b*) children in the same class; and (*c*) children who, on reference to the school register, are found to have returned to school after a short absence.

It should be understood, when the following table is used, that infectious disease is a process, not an entity, and that the process is liable to modification by many circumstances. The period indicated in the second and third columns should,

INCUBATION AND EXCLUSION PERIODS OF THE COMMONER INFECTIOUS DISEASES

Disease.	Usual Incubation Period. (days)	Interval between onset and appearance of rash. (days)	Period of Exclusion. Patients.	Period of Exclusion. Contacts, *i.e.* the other members of the family or household living together as a family, that is, in one tenement.
Scarlet fever.	1–7	1–2	7 days after discharge from hospital or from home isolation (unless "cold in the head," discharge from the nose or ear, sore throat, or "septic spots" be present).	7 days after the removal of the patient to hospital or the beginning of his isolation at home.
Diphtheria	2–7	—	Until pronounced by a medical practitioner to be free from infection.	7 days after the removal of the patient to hospital or the beginning of his isolation at home. If there be any suspicious signs the child should be excluded further until pronounced by a medical practitioner to be free from infection.
Measles	7–14	3-4	14 days after the appearance of the rash if the child appears well.	Infants who have not had the disease should be excluded for 14 days from the date of appearance of the rash in the last case in the house. Other contacts can attend school. Any contact suffering from a cough, cold, chill or red eyes should be immediately excluded.
German Measles.	5–21	0–2	7 days from the appearance of the rash.	None.
Whooping Cough.	6–18	—	28 days from the beginning of the characteristic cough.	Infants who have not had the disease should be excluded for 21 days from the date of onset of the disease in the last case in the house.
Mumps	12–28	—	14 days from the onset of the disease or 7 days from the subsidence of all swelling.	None.
Chickenpox	11–21	0–2	14 days from the date of the appearance of the rash.	None.
*Smallpox	10–21	3	Until the patient is pronounced by a medical practitioner to be free from infection.	21 days unless recently fully vaccinated when exclusion is unnecessary.

* The incubation period of major smallpox is commonly 12 days but that of minor smallpox is more variable and the wide limits given apply to this variety of the disease.

therefore, be regarded as approximate only. Just as infectious diseases behave differently in different individuals so epidemics behave differently in different types of area. The medical officer of health or school medical officer must therefore decide how far the suggestions are applicable to local conditions and what are the best measures of control in his own area. It is,

however, the opinion of the Ministry and the Board that the Rules governing exclusion of contacts should not be more rigid than those suggested.

The following machinery exists for closure of and exclusion from school :—

(*a*) Schools or departments may be closed or individual scholars excluded by the local health authority, or by any two members thereof acting on the advice of their medical officer of health.

(*b*) Schools or departments may be closed for medical reasons by the local education authority, but grant will be withheld unless such closure is done on the advice, or with the approval, of the school medical officer. Such advice or approval may be given only on the ground that closure is necessary for medical reasons.

(*c*) Individual children may be excluded by the school medical officer to prevent the spread of disease, or if the children are in an unclean or verminous state, or if, on account of physical or mental defects, they are unable to receive proper benefit from instruction in school. The local education authority are not required to give special authorisation in each individual case, but the Board of Education must be satisfied that proper arrangements have been made by the local education authority with regard to exclusions.

Little difficulty need arise if the medical officer of health is also the school medical officer. In such a case the officer will find it much more convenient to use his powers as school medical officer. If the offices are distinct, there must be close co-operation between the medical officer of health and the school medical officer, with all possible interchange of information (*Public Health*, September, 1936, pp. 412–19, Forrest, A. W.; and April, 1938, pp. 203–07, Paul, H.; *J. Roy. San. Inst.*, 1939, Vol. 59, pp. 559–65, Duncan Forbes; "A Code of Rules for the Prevention of Communicable Diseases in Schools," The Medical Officers of Schools Assoc., Churchill Ltd., 1940).

The child with special defect

Local education authorities must make every endeavour to ascertain and make provision for the care of all children within their areas who are blind, deaf, physically or mentally defective, or epileptic. Authorities of all but the largest urban areas find that the only satisfactory way of doing this is by co-operation with other areas.

The Special Schools Boarding-out Regulations, 1939, relate to the boarding-out by local education authorities of blind, deaf or defective children in homes conveniently near to special schools. No child may be boarded out without the consent

of his parent. A blind child and a deaf child, or more than two blind children, or more than two deaf children, or more than three defective children may not be boarded out in the same home at the same time without the consent of the Board of Education, and a child may not be boarded out in a home in which more than four children are already resident without the previous approval of the Board. The foster-parent must enter into a written undertaking with the responsible authority regarding the proper care of the child and his attendance at the special school, and the child must be visited regularly at the home by a visitor on behalf of the authority.

The mentally sub-normal child

(1) *The retarded child.* "Dull" children are those born with an inferior mental equipment; "backward" children are those who have been hindered in their normal development by external agencies. Such agencies include (1) irregular attendance at school; (2) inefficient teaching in earlier years; (3) general physical defect; (4) special physical defect, such as enlarged tonsils and adenoids, eye defects, deafness, speech defects, etc.; and (5) character defects. Retarded children were estimated by Burt in 1918 to form about 10 per cent. of all children attending London elementary schools. For the large majority of dull and backward children the proper school is the public elementary and not the special school. If possible, special classes should be formed for them within the ordinary schools, and the curriculum and time-table should be modified to suit their special needs.

(2) *The mentally defective child.* The Mental Deficiency Acts, 1913 to 1927, are administered centrally by the Board of Control and locally by the councils of counties and of county boroughs through their mental deficiency committees. The duty of ascertaining which children between the ages of seven and sixteen years are defective falls on the local authority for elementary education which, it will be remembered, may be the council of a municipal borough or urban district. The following definitions should be noted :—

"Mental defectiveness" means a condition of arrested or incomplete development of mind, existing before the age of eighteen years, whether arising from inherent causes or induced by disease or injury.

"Idiots" are persons in whose case there exists mental defectiveness of such a degree that they are unable to guard themselves against common physical dangers.

"Imbeciles" are persons in whose case there exists mental defectiveness which, though not amounting to idiocy, is yet so pronounced that they are incapable of managing themselves or their affairs, or, in the case of children, of being taught to do so.

"Feeble-minded persons" are those in whose case there exists mental defectiveness which, though not amounting to imbecility, is yet so pronounced that they require care, supervision and control for their own protection, or for the protection of others, and, in the case of children, that they, by reason of such defectiveness, appear to be *permanently* incapable of receiving proper benefit from the instruction in ordinary schools.

"Moral defectives" are persons in whose case there exists mental defectiveness coupled with strongly vicious or criminal propensities, and who require care, supervision and control for their own protection or for the protection of others.

EXCEPTIONAL CHILDREN IN LONDON IN 1938.

Classification.	Number at certified special schools.	Total number in each group.	Incidence per 1,000 children on roll.
Blind children	113	115	0·2
Partially sighted children	489	510	1·1
Deaf children	435	441	0·9
Partially deaf children	136	143	0·3
Mentally defective children—			
Feeble-minded children	2,825	2,853	6·2
Epileptic children—			
Children suffering from severe epilepsy	85	91	0·2
Physically defective children—			
Tuberculous children—			
Pulmonary	378	414	0·9
Non-pulmonary	525	540	1·1
Delicate children	2,361	8,091	19·8
Crippled children	1,791	1,811	3·9
Children with heart disease	1,805	1,824	3·9

The first duty of a local education authority is ascertainment, and in this connection the examination of children must be made by a medical officer specially approved by the Board of Education (known as the certifying officer). Parents are required to submit their children to such an examination.

An examination of a child for evidence of mental deficiency should include :—

(1) Graduated intelligence tests of the Binet-Simon or Stanford Revision type.

(2) Performance tests, designed to estimate motor control and ability to handle concrete things.

(3) Tests of scholastic attainment.

(4) Social tests or general questions intended to elucidate the mental relationship of the child to home, out-of-school occupations, friends and the world in which he moves.

By means of intelligence tests the Intelligence Quotient may be calculated, *i.e.* :—

$$\frac{\text{mental age}}{\text{actual age}} \times 100 ;$$

Children showing an I.Q. under 25 may be regarded as idiots, under 50 as imbeciles, and under 70 as feeble-minded (Annual Report, Chief Medical Officer, Board of Education, 1935, pp. 119–127).

Attendance at a special school can be enforced, and children are retained in such institutions till the age of sixteen years. If the local education authority are then of opinion that in the case of any of them further institutional care, guardianship or supervision is required, their names must be notified to the local authority for mental deficiency. The local authority for mental deficiency, if they consider that institutional care or guardianship is necessary, must present a petition, accompanied by two medical certificates and a statutory declaration, to a special justice of the peace, a stipendiary magistrate or a county court judge.

The Chief Medical Officer of the Board of Education recommended in his Report for 1928 (pp. 92–107) that all children under eleven years with an I.Q. under 50, and all those over eleven years with an I.Q. under 55, should be classed as notifiable to the local supervising authority, *i.e.* the county council or county borough council. High-grade defectives and dull and backward children should be dealt with together and provided with suitable education in special classes or day special schools. It must not be forgotten that it costs twice as much to educate a child in a day special school as in an ordinary school and six times as much in a residential school. It is estimated that about half the children educated in such day special schools are capable of doing remunerative work after leaving school. An after-care committee can render great help in this direction.

In the Report of the Joint Committee on Mental Deficiency of the Board of Education and the Board of Control, 1929, it was concluded by Dr. Lewis that the incidence of feeble-mindedness among children between the ages of seven and sixteen was 15·13 per 1,000 children on the registers of the public elementary schools in urban areas and 28·04 in rural, or a mean incidence of 20·74 per 1,000 school population. The Committee estimated that there were 300,000 mentally defective persons (in the social sense) in England and Wales, or 8 per 1,000 of the population, and in addition, some 35,000 children who were defective in the educational rather than in the social sense, and who required special school education. (*Proc. Roy. Soc. Med.*, October, 1934, pp. 1729–1748, " Discussion on the Value of the Treatment of Mental Deficiency," Shrubsall and

others ; "Mental Deficiency Practice," Shrubsall and Williams, Univ. of London Press, 1932.)

Child guidance clinics have been instituted in a number of areas to deal with the so-called maladjusted child showing some form of persistent behaviour disorder. During 1938, 1,247 London school children, of whom 777 were boys and 470 girls, attended child guidance clinics. At these clinics the mother of the child is interviewed, the child is examined physically and psychologically, the home and school are visited to discover if possible the factors causing maladjustment, the child is observed at work and play, and finally consideration is given to its future at a conference attended by the various people who have been interested in the case. A fully equipped clinic should be staffed by psychiatrists, psychologists and social workers, and should act in close connection with the school medical service. Cases are referred by school medical officers, teachers, care committees, private practitioners, parents, children's courts and probation officers. The causes of reference include backwardness, nervousness, enuresis, bad temper, stammer, unusual fears, aggressiveness and spitefulness, theft, truancy, wandering and refusal to submit to home or school control. (Annual Report of the Chief Medical Officer, Board of Education, 1934, pp. 114–118.)

The physically defective child

(1) *Blind and partially sighted children.* In the Education Act, 1921, "blind" means too blind to be able to read the ordinary school books used by children. (See also p. 271.) Children so certified fall into one of the following groups :—

(*a*) those who cannot be taught by methods involving the use of sight ;

(*b*) those who can see well enough to be taught by special methods involving the use of sight ;

(*c*) those who are suffering from conditions such as myopia, which may be aggravated by following the ordinary school curriculum.

Children in category (*a*) usually require to be sent to residential schools at the age of seven, and need vocational training at sixteen. In 1938 there were 1,676 such registered blind children between the ages of five and sixteen in England and Wales. Children in categories (*b*) and (*c*) are partially sighted, and constitute a separate problem. Those with a visual acuity after correction of 6/24 or worse, may be regarded as partially sighted. Their number amounts probably to not less than 1 per 1,000 children on the elementary school registers. They should be educated, when possible, in special classes forming an integral part of ordinary schools, though children suffering from acute or subacute inflammation of the eyes should be sent

to special hospital schools. Such partially sighted children require a special curriculum and *régime*, ordinary methods of instruction in reading and writing being obviously unsuitable. (Report of Committee of Board of Education on "Partially Sighted Children," 1934; *Medical Officer*, 11th March, 1939, pp. 97–99, Furniss, A.).

(2) *The deaf child.* For the purposes of the Education Act, 1921, a "deaf" child means one too deaf to be taught in a class of hearing children in an elementary school. In a Report of the Committee of the Board of Education on Children with Defective Hearing (1938), such children are divided into the following educational grades:—

Grade I.: Children with defective hearing who can, nevertheless, without special arrangements *of any kind*, obtain proper benefit from the education provided in an ordinary school—elementary, secondary or technical.

Grade II.: Children whose hearing is defective to such a degree that they require for their education special arrangements or facilities, but not the educational methods used for deaf children without naturally acquired speech or language. These facilities range from a favourable position in the ordinary school classroom to attendance at a special class or school.

Grade IIa.: Those children within Grade II. who can make satisfactory progress in ordinary classes in ordinary schools provided they are given some help, whether by way of favourable position in class, by individual hearing-aids, or by tuition in lip-reading.

Grade IIb.: Those children within Grade II. who, even with the help of favourable position in the class, individual hearing-aids or tuition in lip-reading, fail to make satisfactory progress in ordinary classes in ordinary schools.

Grade III.: Children whose hearing is so defective and whose speech and language are so little developed that they require education by methods used for deaf children without naturally acquired speech or language. This grade includes the totally deaf.

Macleod Yearsley in an analysis of 4,324 cases of "educational deafness" found 30 per cent. to be congenital and 70 per cent. acquired. Of the acquired cases 23 per cent. were completely deaf and 17 per cent. nearly so. The commonest causes of acquired deafness were middle ear chronic catarrh, 23·9 per cent; middle ear suppuration (cause unknown), 23 per cent.; infectious disease of the central nervous system, 12·6 per cent.; measles, 9·2 per cent.; scarlet fever, 8·4 per cent.; other infectious diseases, 6·1 per cent.; congenital syphilis, 6·2 per cent.; and injury, 4·5 per cent.

"Routine group testing of all children in ordinary schools with the gramophone audiometer should be the basis of any scheme

for the ascertainment and treatment of children with defective hearing. The spoken voice test at 20 feet is the most suitable for use in determining whether or not a child is in need of any form of special educational provision. The analysis of the acuity of hearing by examination with the pure tone audiometer forms a scientific basis for the provision of a hearing aid or the teaching of speech to a child with defective hearing. This instrument should be available for use by the aural surgeon to the education authority or school for the deaf."

The gramophone audiometer speaks a series of 2- or 3-digit numbers in a measured gradation of intensity. The fall in intensity from one set of digits to the next in the series is 3 decibels—the decibel being a physical unit in terms of which differences in sound intensities can be expressed. The gramophone has a number of headphones, one of which is placed over a child's ear, each ear being tested separately. Twenty-four or more children can be tested at one time. The numbers are written down by the children on special forms and normal hearing is taken as lying between 6 decibels and —3 decibels. A correct record at 6 decibels or better is regarded as satisfying the test—a correct record being two correct digits out of the three.

The pure tone audiometer is an electrical generator of approximately pure tones which can be varied both in pitch and intensity at the will of the operator. Its object is to determine, at each pitch, the faintest sound which the subject can hear. It differs from the gramophone audiometer as it not only indicates the amount of "hearing loss" but also the nature and the situation of the defect. The result of the test is graphically shown on a chart known as an audiogram. (Annual Report, London County Council, Vol. IV. (Part III.), 1936, p. 116; *Medical Officer*, 19th August, 1939, p. 75, Turner, A. C.)

During 1938 70,960 children in the London County Council schools were tested by the gramophone audiometer and 6·5 per cent. failed in one or both ears.

In his Annual Report for 1936, Dr. Frazer, of Liverpool, states that children with an average loss of hearing up to 25 decibels (as determined by the pure tone audiometer) can remain in the elementary schools provided they are placed in the front seats. The partially deaf with a loss of 25 to 50 decibels are suitable for training in special classes and for training by hearing-aids. Those with a loss of between 50 and 100 decibels form the majority of the children in the "deaf school" and benefit considerably by the use of hearing-aids.

Grade IIb children should attend either a day or a residential school for the deaf and be taught in separately organised

classes for the partially deaf. Grade III. or completely deaf children are better taught in residential schools. For both these groups vocational training should be provided. The cost of day special school education is about £40 and residential school about £80 per child per annum. It should be remembered that special provision has to be made for the children who are not only deaf but suffer from mental defect as well (*Lancet*, 7th October, 1939, pp. 781–785, "Defective Hearing and Nutrition in Children," Kerridge, Phyllis M. Tookey).

(3) *The epileptic child.* If the fits occur during school hours, the child is usually excluded from school. Should, however, the attacks come on at night, the child may as a rule attend school. Special provision should be made in homes and colonies for epileptics who are at the same time mentally defective. (Annual Report of the Chief Medical Officer, Board of Education, 1932, pp. 68–77.)

(4) *The cripple child.* In 1930 it was estimated that the proportion of crippled children of school age in England and Wales amounted to 9·2 per 1,000 average attendance. In London during 1938, the figure was 3·9 per 1,000 on the school registers. It is certain that in a large number of cases deformity can be prevented or the condition improved sufficiently to enable the sufferers later on to take a share in industry, if the disability is dealt with early and efficiently, and if suitable and adequate educational training is given.

Apart from congenital defects, the main illnesses causing crippling attack the child most commonly within the first five years of life: infantile paralysis, from 0 to 3 years; rickets, from 6 months to 2 years; non-pulmonary tuberculosis, from 0 to 5 years. The early ascertainment of these defects is essential, and there must be active co-operation of all bodies dealing with children in their early years. Once the defect has been detected, the following means exist for dealing with it:—

(*a*) Hospital schools or open-air residential schools.

(*b*) Orthopædic and after-care clinics—local centres organised and managed in connection with a central hospital. These clinics are used for (1) the examination by the orthopædic surgeon of cases sent to him in consultation; (2) the after-treatment and supervision of cases discharged from hospital schools; (3) the treatment of such cases as can efficiently be treated as out-patients; (4) the renewing and repairing of plasters and the fitting and examining of splints and appliances. The staff should include an orthopædic surgeon, visiting once a month, and an orthopædic sister, attending once a week or oftener if required.

(*c*) Cripple schools—day or residential.

(*d*) Remedial exercise clinic under the charge of a fully

qualified remedial gymnast (Certificate of the Chartered Society of Massage and Medical Gymnastics). Treatment by remedial exercises and massage, and occasionally electrical treatment, may be given to cases of scoliosis, flat-foot, poor chest development and kyphosis, knock-knees, and to certain cases of paralysis, while breathing exercises may be given after operations for enlarged tonsils and adenoids.

(*e*) Vocational courses for those above school age who are suffering from severe forms of crippling.

There must be effective following up of the children by the school nurses to ensure regular attendance at the orthopædic clinic. (Annual Report of the Chief Medical Officer, Board of Education, 1933, pp. 107–119.)

(5) *The rheumatic child.* A scheme for the prevention of acute rheumatism and rheumatic carditis should include the following: (1) prompt ascertainment of suspected cases; (2) accurate diagnosis; (3) immediately available (*i.e* without "waiting list" delay) in-patient hospital accommodation for patients in the acute stage (such accommodation should be provided by the public health authority); (4) direct removal from hospital to a special institution for prolonged and well-regulated convalescence where, in addition to treatment, appropriate education would be provided; (5) provision for children whose hearts have been permanently damaged—*e.g.* in day special schools; (6) after-care and supervision for children who have returned to ordinary schools. In a few areas, *e.g.* Kensington and Paddington, acute rheumatism, which includes arthritis with temperature, chorea and carditis, occurring in children under the age of sixteen has been made notifiable. The school medical officer should keep a register of all children in his area suffering from the principal manifestations of rheumatism, and he should see that parents and teachers are informed of the significance of the disease and its early symptoms. The possible ill-effects of damp rooms and damp clothes or boots should be emphasised. Rheumatism supervisory centres have been established in various towns. These are centres for (1) examination of suspects, (2) re-inspection of cases, (3) circulation of propaganda, (4) registration, following-up and after-care. Most acute cases can receive hospital treatment, but it is not always easy to secure the retention of the patient sufficiently long after the subsidence of the acute symptoms. Beds are, however, being gradually set aside by large authorities for the prolonged treatment of rheumatic children. Open-air schools are suitable for the treatment of debilitated, ill-nourished children likely to develop rheumatic symptoms, but are not good for convalescents from the acute disease. In London the County Council have provided 900 beds—roughly, 2·5 beds per 1,000 children in average attend-

ance. The number of children actually admitted to these beds in 1938 represented 5·1 per 1,000 in average attendance. Of all children discharged, 78·7 per cent. were regarded as fit to resume normal life, while 18·4 per cent. were partially incapacitated by reason of cardiac involvement, and 2·9 per cent. were permanently unfit. (Annual Report of the Chief Medical Officer, Board of Education, 1935, pp. 102–111 ; *Lancet*, 14th November, 1942, pp. 563–567, Miller, R. ; *B.M.J.*, 6th February, 1943, pp. 154–158, and 30th June, 1943, pp. 121–125, Hubble, D.)

(6) *The child suffering from speech defect.* Stammering is the commonest defect, but other defects may be due to some purely organic cause, such as cleft palate. Some workers consider that stammering is occasionally caused by attempting to transfer left- to right-handed work. According to Kerr, in pure left-handedness there is no disposition to speech defects, but in the case of poor dextrality, associated defects, speech among them, are commoner than the average, whilst there is little evidence of any close connection between direct production of speech defect and stress from educational training of the hand. Classes for children suffering from defective speech have been instituted by a good many authorities. Such classes are usually part-time, children attending on two sessions of three-quarters of an hour to one hour each a week. The method commonly practised includes breathing exercises followed by short periods of rest and relaxation, with speech training of a rhythmic character. Some 50 per cent. of the children are said to be cured on leaving the class, and 30 per cent. remain cured after an interval of a year. In addition 30 per cent. are improved, while in 40 per cent. no permanent benefit is found. The teachers must be specially trained and of suitable personality, each child should be examined medically before admission to the class, the sympathy of the parents should be enlisted, careful records should be kept and all children should be followed up. The subject is reviewed in the Annual Reports of the Chief Medical Officer, Board of Education, 1926, pp. 129–133, and 1934, pp. 96–103 ; and in "The Nature and Treatment of Stammering," Boome and Richardson, (Methuen & Co. Ltd., 1931) ; (see also *Physiological Reviews*, Baltimore, 1939, Vol. 19, pp. 49–62, Cobb, S. and Cole, E. M.).

Open-air education. Such education may be given by means of classes in playgrounds or parks, open-air journeys and in various forms of open-air classrooms. The most comprehensive form, however, is provided in the open-air school.

The day open-air recovery school. The following classes of children are specially likely to benefit from attendance at such a school :—

1. Children suffering from malnutrition, rickets, anæmia.
2. Delicate children living in the same house as a notified consumptive.
3. Children with tuberculous glands in the neck.
4. Children convalescent after debilitating diseases, such as pneumonia, measles, or whooping-cough.
5. Children convalescent after operations for adenoids, glands in the neck, etc.
6. Children suffering from blepharitis and other chronic non-infectious eye diseases associated with malnutrition.
7. Certain types of crippled children.
8. Nervous and highly-strung children.
9. "Partially sighted" children, whose condition is due to myopia or other chronic defect.
10. Stammering children.

(Rheumatic children, including those suffering from chorea, are not as a rule suitable subjects.)

The ideal site is on the outskirts of the town, preferably on that side from which the prevailing wind blows. It should not be more than a quarter of a mile from a tram route or a road capable of taking motor omnibuses, and should slope preferably to the south and have a belt of trees or rising land for protection on the north and east. The site should be large enough to provide a playing-field and a school garden; for a school of 100 to 200 children the minimum is two acres. The twin type of classroom is probably the most suitable as it can be opened on three sides and the two rooms thrown into one. The sides of the rooms should be glazed and provision made by means of hoppers above the windows for constant through ventilation. Verandahs are useful, but not essential. A separate rest-shed is necessary in a large school, but otherwise a room which can be used as a general dining-room and as a rest-room for a proportion of the children will suffice. Space for teaching, dining and resting should be largely interchangeable. Light trestle tables can be used for educational as well as for dining purposes; and simple folding individual desks or tables and a locker for each child should be provided. A shower-bath installation, kitchen and well-heated storage accommodation, teachers' and medical rooms are necessary. Ample lavatory arrangements should be made, and there should be a space for each child to keep its own towel, hair and tooth brushes. Some form of heating is necessary—as a rule the temperature of an open-air classroom provided with heating is only 6°–8° F. above the temperature of the outside air in winter. Heating, however, has a good psychological effect in unpleasant weather and keeps the rooms and their contents dry. The main types of heating used are radiators, floor-heating, panel-heating in the walls or ceilings, and slow combustion stoves. Probably floor-heating is the best, though not the cheapest. Accommodation should be provided for a minimum of sixty children *i.e.* two classes.

A medical officer should visit the school once a week, while a school nurse should be attached to the school for whole or part time. The school dentist should visit the school from time to time, and the children should be weighed fortnightly.

The duration of stay should be for at least six months, save in cases sent for recovery and training, *e.g.* after operation for tonsils and adenoids, when a stay of a month or two may suffice. Breakfast, dinner and tea should be provided, a midday rest of one to two hours should be arranged, and suitable clothing must be worn by the children, provided by the school if necessary (jerseys, overcoats, mackintosh capes). It is nearly always necessary to arrange for the conveyance of the children to and from school. The curriculum should be specially designed, and should include as much practical instruction in the open air as possible. Attention should be paid to training the child in a hygienic way of life (Annual Reports, Chief Medical Officer, Board of Education, 1927, Appendix A, pp. 149–152; and 1934, pp. 104–113; Board of Education Circular 1444, 1936, and Memo. 183, September, 1938. An account of school and holiday camps will be found in the Report for 1936, pp. 95–106.)

The following tables give information relating to the **cost of the School Medical Service in England and Wales.** ("Provisional" indicates that the figures are pre-audit.)

PROVISIONAL NET EXPENDITURE OF LOCAL EDUCATION AUTHORITIES ON SPECIAL SERVICES AND GRANTS PAID BY THE BOARD OF EDUCATION TO VOLUNTARY SPECIAL SCHOOLS, PLAY CENTRES AND NURSERY SCHOOLS IN THE YEAR 1938–39.

	Net Expenditure of Local Education Authorities to be met from Exchequer Grants and Local Rates.	Grants paid by Board to Voluntary Institutions.
	1938–39.	1938–39.
	£	£
Medical Inspection and Treatment .	2,605,692	—
Special Schools	2,380,782	34,970
Organisation of Physical Training .	115,818	—
Play Centres	75,769	11,113
Nursery Schools	124,104	12,997
Provision of Meals	942,803	—
Employers' Contributions, Teachers (Superannuation) Act, 1925 .	33,090	*
Totals	6,278,058	59,080

* These grants are included in the grants to special schools.

The following table sets out the approximate expenditure in different types of area :—

MEDICAL INSPECTION AND TREATMENT. ENGLAND AND WALES.

Type of Area.	Number of Areas.	Average Attendance, 1938–39.	Net Expenditure 1938–39 (Provisional Figures).	Cost in 1938–39 per unit of Average Attendance. 1938–39.	
			£	*s.*	*d.*
Counties	62	1,791,454	956,283	10	8
County Boroughs	83	1,529,863	803,252	10	6
Non-county Boroughs	150	639,643	423,688	13	3
Urban Districts	19	92,957	53,148	11	
London	1	378,839	369,321	19	
Total	315	4,432,756	2,605,692	11	9

During 1936–37 the average net expenditure on "special services" per child was—in London, £3 1*s.* 1*d.*; in counties, 15*s.* 4*d.*; in county boroughs, £1 5*s.* 3*d.*; and in boroughs and urban districts, £1 0*s.* 11*d.*

SCHOOL PREMISES

(See "Elementary School Buildings," Board of Education Educational Pamphlet No. 107, 1937; "School Buildings. Economy in Construction," Board of Education Circulars 1419, July, 1932, and "Light Construction Buildings," 1468, May, 1939.)

Site. The site should be easy of access. Entrances from main traffic routes should be avoided but, where this is not possible, they should be recessed and fitted with crush barriers. Two acres per department is a minimum. Senior schools require additional space for playing fields. Room for extension must be considered. The buildings should stand at least 60 feet from a street and face south. If the ground is uneven the slope should be followed with reason or buildings planned in detached units. Proximity to high buildings and noisy and offensive trades, etc., should be avoided.

The building. Every part of the building should be as fireproof as possible. On level sites single-storey buildings may be erected on a concrete raft which serves for under-flooring and saves foundations. In general, the rooms (with the exception of halls) need not be more than 11 feet high if the lighting and ventilation are satisfactory. Corridors should be from 6 to 8 feet wide, well lighted and placed so as to act as protection against cold and rough winds. For single-storey buildings, 11-inch cavity or 9-inch solid walls are sufficient; two-storey buildings require 14-inch solid or 16-inch cavity walls. Washable and sound-absorbent materials should be used where necessary. (It is now possible to reconcile good hygiene and good acoustics.)

The walls of cloak-rooms and lavatories should be lined to a height of 5 feet with a hard, smooth surface readily washed.

Dust-binding oils should be used for wooden floors. The oil,

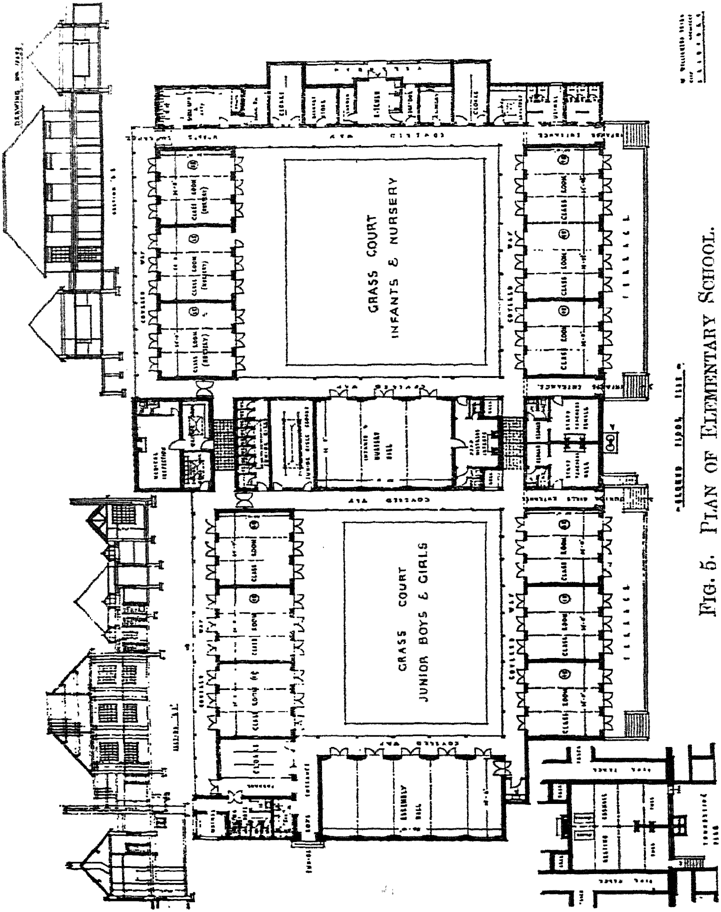

FIG. 5. PLAN OF ELEMENTARY SCHOOL.
(City of Bradford Education Committee.)

which takes two or three days to soak in, may be applied at intervals. From time to time the floors need washing with soap and soda. The floors of corridors, cloak-rooms and

lavatories should be of cement finished with granolithic face in various colours.

The alternatives to brick construction are timber framing or light steel structures. Timber-built schools, on brick or concrete foundations, with specially selected wood, such as Douglas fir for framework and flooring and red cedar for weather boards, will last forty years or more and are not expensive to maintain.

The plan of the building should ensure compactness for convenience and ample light and air for health. Single-storey buildings are preferable and owing to lightness in structure need not be more expensive than a two-storey building. There is no particular type of plan adaptable for all purposes. The most popular type is the one in which rooms are arranged round four sides of a central court, a corridor or open verandah running round the inner side. This arrangement is, however, wasteful of ground, does not lend itself easily to expansion and provides an unsatisfactory aspect for at least one of the four sides.

For the sake of economy it is advisable to concentrate sanitary accommodation as far as possible in order to save drainage and plumbing, and there will usually be a saving in the cubic contents of a building if sanitary offices, cloak-rooms, lavatories, staff rooms and other small rooms, all of which may be low, are grouped together apart from the larger and higher rooms. Where the number of children coming from a distance justifies it a light and inexpensive bicycle shed should be provided.

Classrooms should in no case have a superficial area of less than 480 square feet, 520 square feet being the most suitable size. They should never be less than 20 feet wide and, when radiators cannot be hidden or recessed, 21 feet 6 inches is necessary. A clear view of the blackboard may be difficult to obtain from distances greater than 25 feet or less than 7 feet. There should be 1 foot 4 inches on one side of each child. Rooms for science, handicraft, etc., need special consideration as regards cubic space.

The assembly hall should not provide less than 1,800 square feet save in the smaller infants' schools. In the senior and larger junior schools some kind of a stage or platform should be provided and at the opposite end to the stage there should be a small room for a cinematograph projector. There should be at least two separate entrances. The question of acoustics is very important.

Schools should provide so many teaching spaces affording not less than 10 square feet for each young child and 12 square feet for each senior. The unduly large class and two classes in

one room will in course of time disappear. The ideal school envisaged should be a single-storey building with free access of air and sunshine to every part. Playgrounds should be well away from the building and space left for gardens and open-air work. Playgrounds should be rectangular in shape and in no case less than 50 feet wide. One playground may be used by the younger boys and girls if the provision of offices makes this a suitable arrangement. The standard to aim at is not less than 2 acres per department but, where two or more departments have to be built on the same site, rather less ground is necessary in proportion. No senior school should have a playing field of less than 2 to 3 acres; for a school of 300 or more pupils 3 to 5 acres, and where the numbers approach 500 pupils 6 to 7 acres are necessary, preferably on the same site as the school.

Ventilation. Satisfactory ventilation can usually be secured by natural means. Windows should be placed on opposite sides of the room and all should be made to open if possible into the external air. One of the best types of window has the lower pane arranged to open inwards as a hopper inlet with side pieces, the upper part of the window being hung horizontally on its centre to swing in order to give as large an opening as possible. There should be ample means of flushing the classroom with fresh air at the end of every lesson.

Lighting. See p. 438.

Heating. A temperature of from 56° to 60° F. should be maintained in the classrooms, and in the infant school the temperature should always be at least 60° F. The rooms and their furnishings should be properly warmed before the children arrive. An air-cooling power of 7, as registered by the kata-thermometer, should be aimed at, and the temperature should never fall below 55° F., nor the cooling power rise above 8 or 9. ("Methods of Heating and Ventilating Schools, and their Influence on Health," *Medical Officer*, December 8, 1928, Vernon, H. M.) See p. 431 for methods of heating.

Seats and desks. Single seats and desks are the most satisfactory, as the desk can be fitted to each child and there is less likelihood of the spread of infectious disease or verminous conditions. Dual desks are the next best, though they are not without disadvantages, while the "Sheffield system," where continuous desks with single seats are used, needs care and supervision. As a child spends three to five hours a day sitting, a support for the back is essential whatever type of desk is used. Errors of posture may arise from the use of unsuitable school furniture, and to prevent this it is usual to have three different sizes of seats and desks for the older children to accommodate their different heights, but adjustable seats and desks are also made. In the infant schools small tables and

chairs may be used. The relationship of the edge of the desk to the edge of the seat is important, and three distances are recognised—*zero* when the edge of the desk is vertically in line with the edge of the seat, *minus* when it overhangs it and *plus* when there is an interval between. A good type of desk should be adjustable so as to get the proper distance required ; the zero and minus are suitable for reading and writing, while the plus is necessary when the child is standing up or moving in or out of his place.

The general requirements of a good seat and desk are :—

1. They should suit the size of the child.
2. They should allow freedom of movement and change and adjustment of position rapidly and noiselessly.
3. Each child should be provided with as much space as possible.
4. The seat and desk should be free from dangerous hinges or joints.
5. They should provide storage for books, etc.

The seat should be a little hollowed with an inclination backwards—to take two-thirds of the child's thigh and allow the feet to rest on the floor when sitting with knees bent at a right angle.

The height of the desk from the seat is known as the "difference," and this should be elbow height or a little higher. The breadth of the desk should be half the length of the forearm and outstretched fingers. A child should be able to write without raising the shoulders. A slope of 10 degrees for writing is sufficient. There are various standards for the length of desks, but 26 inches seems adequate. Foot-rests are regarded by Kerr (who has been largely quoted in this section) as "unphysiological, unnecessary and costly." Back-rests should support the general curve of the spine, and there should be support as high as the shoulder-blades. The modern practice is to furnish classrooms with chairs and flat-topped tables which require more space than desks. Whatever type of furniture is used it should be so arranged that every pupil may be able to leave his place without disturbing others and that there is easy access for the teacher. (Annual Report of the Chief Medical Officer, Board of Education, 1932, pp. 92–99, "The Posture of School Children.")

Cloakrooms and lockers. To avoid congestion at particular parts of the building, the question of attaching cloakrooms and lockers to classrooms might be considered. Otherwise they are most conveniently placed near the pupils' entrance. They should be provided with sufficient gates or doors. Separate accommodation should be provided in every case for each sex in senior mixed schools and in certain cases in junior mixed schools. Thorough ventilation and disconnection from the

main building are essential and all cloakrooms should be well lighted and heated.

The essential equipment consists of shoe and boot cages, racks or pegs for hats and provision for hanging coats. Pegs may be arranged zigzag or in a row with intervals of at least 10 inches for boys and 12 inches for girls and should be well within the reach of young children and infants. There should be a gangway of at least 5 feet between the stands. A separate drying room is an advantage and may be conveniently placed near the lavatories or near the hot-water boiler in the basement. In rural schools a large stove, properly guarded, may be placed in a cloakroom and racks provided on which wet clothes can be hung.

Lavatories. A minimum of twelve basins for the first 100 pupils and four extra basins for every additional 100 pupils should be provided. For the infants' schools the basins should be of varying heights, probably, 14, 17 and 20 inches from the ground. For juniors and seniors, troughs and sprays may be used and all should be installed at convenient heights. Hot water with control taps to prevent scalding should be provided and an adequate supply of soap and towels is necessary. The common roller towel should be prohibited.

There should be a plentiful supply of drinking water obtained from fountains of the bubble or spray type, thus eliminating drinking cups. The most suitable patterns are of the upward jet variety in which the water is delivered from a covered orifice. Drinking fountains should be provided at the rate of one for every 100 children in large schools but small schools should have at least two. A sink, with taps for filling jugs, is desirable.

School baths. Provision should be made for bathing on the school premises. To economise floor-space shower baths are the best, though slipper baths will be required as well. At Aberdeen a well-devised cubicle spray bath installation has been provided by the education authority for the use of school children. It consists of twenty-four paired sprays and dressing-boxes, each enclosed by a curtain. Two groups of twenty-four young children (or three groups of older children) can be bathed hourly.

Both hot and cold water should be provided, and dressing-boxes will be needed, and the bathing arrangements should be under supervision. This training in personal cleanliness is most valuable, and the children should be taught to realise that it forms a part of the school routine. Swimming should be taught to children attending elementary schools, and every use should be made of the public swimming-baths for this purpose. Before entering the bath each child should have a thorough cleansing of the skin, especially the feet, and any who are verminous or have discharging ears, or who are in any way likely to spread

infection, should be excluded. Overcrowding should be avoided as this makes individual instruction in swimming impossible.

Water supply. Where there is no public water supply and well water is being used, 5 to 7 gallons per head per day should be provided if possible. If rain-water is the only supply, a minimum of 40 days' storage is suggested with a restricted consumption of 1 gallon per head. A storage tank constructed of impervious material, such as concrete, should be used; the rain-pipe should discharge within the tank, and the supply tap or suction pipe of the pump should be 3 inches above the bottom. The tank should be provided with adequate means for cleansing, and should be ventilated in such a way as to exclude birds and other animals; a protected overflow should discharge into the open air. If constructed wholly or partially underground, it should not be less than 60 feet from any cesspool or privy, and the sides should be brought at least 6 inches above the highest part of the adjacent ground. If above the ground a cover of more permanent material than wood is necessary, and if below there should be an impervious cover with a covered manhole brought 6 inches above the ground. Collecting surfaces and down-pipes should be inspected and cleansed at intervals, and the tank should be emptied and cleansed at least once a year. A simple form of filter is sometimes used. (Min. of Health, Memo. 183W., 1934.)

Closets should either be within the main building or be closely connected by a covered way. It is an advantage to be able to reach them from the playground. The approaches should be separate for the older boys and girls. In the case of infants there may be a common approach but internal separation of boys' and girls' accommodation is necessary. Each closet should be at least 2 feet 3 inches wide and the door 3 inches short at the bottom and 6 inches short at the top. The partitions between the closets should be carried up 6 feet only. Each one should have its own flush of an instantaneous type and the chains should be of a convenient length. The floors should be made of impervious material and the walls should have a smooth, hard finish. The seats and sizes of the openings should be regulated to suit the ages of the children and a sufficiency of toilet paper should be available.

Accommodation on the following scale should be provided :—

Boys. Four closets for the first 100 and three for each succeeding 100, and in addition 10-foot run of urinal per 100 boys.

Girls. Six closets for the first 100 and four for each succeeding 100.

In rural areas the type of dry system employed is less important than its proper maintenance. Generally speaking, chemical closets are unsuitable for use in schools.

Disposal of excreta and waste waters in country districts

In country districts when water is available for flushing but there are no sewers, water-closets should be drained into a cesspool or into a water-tight tank with an overflow discharging on to a filter or a suitable area of land for irrigation. Rain-water should always be excluded. Disposal of sewage or foul wastes either by subsoil irrigation or by discharge into a ditch is unsatisfactory. When closets with pails are used, the pails should be made of galvanised iron; they should fit accurately and come as close up to the seat as possible. Duplicate sets are necessary, and, after cleansing, they should be wiped over with crude cresol. A receptacle should be provided for dry earth or ashes used for covering dejecta. When pails are emptied by a local conservancy system a small quantity of cresol may be left in the pail instead of absorbent material. Pail contents should be removed daily in suitable receptacles and disposed of without risk of nuisance or pollution. When fixed receptacles are used they must conform to model bylaws (see pp. 537 and 540).

Foul wastes from urinals, sinks, lavatory basins, etc., must always be disposed of separately; they may be run into a cesspool or on to an irrigation area if there are no sewers. If the ground round a school is small, waste waters may have to be run into movable receptacles containing absorbent material; these require daily attention to prevent nuisance; in new schools sufficient ground should be provided to make this expedient unnecessary. (Ministry of Health Memo. on the arrangements for drainage and disposal of waste matters and for water supply at schools, 163K., 1932.)

SECTION IV

PERSONAL HYGIENE

By G. P. Crowden, D.Sc., M.R.C.P.

The rules of personal hygiene are essentially based on the physiological requirements of man for the maintenance of health, comfort and efficiency, and of the child for normal growth, development and activity. Whereas public health safeguards the community against the errors and abnormalities of the individual, the object of education and training in personal hygiene is to safeguard the individual against the hazards which are inseparable from life in crowded communities. The former is largely purchasable with money, while personal health is only maintainable at the expense of individual effort in learning and applying the rules of personal hygiene.

Primary needs. The maintenance of life by supplying the primary needs of the body for oxygen from the air, water and food is not by any means the only consideration from the point of view of health.

Air, apart from its value as the source of oxygen, is the immediate and essential external environment of man from birth, and its physical properties, temperature, humidity and movement influence the loss of heat and moisture from the skin and thus profoundly affect the temperature-regulating mechanism of the body.

Water is the essential medium in which the processes of digestion, absorption and metabolism take place, and an adequate daily intake of water is a most important factor in maintaining the normal action of the excretory organs.

Food is not only the essential source of energy to the body, but the vital processes of digestion, absorption, metabolism, growth and repair are absolutely dependent on the provision in the food of such constituents as certain amino-acids, inorganic salts and vitamins. Moreover, the proper functioning of the excretory organs is governed by the choice and balancing of constituents of the diet, while cleanliness in the preparation and storage of food is a matter of primary importance to family health.

Muscular activity in one form or another is essential for growth and development and for the maintenance of health. The open air and sunlight not only stimulate the body, but

naturally help metabolism and increase the resistance of the body to disease. Sedentary occupations, crowded dwellings, bad ventilation, smoke-polluted atmosphere and dirty conditions in homes as well as in the individual are factors injurious to health unless habits of good personal hygiene in the individual and the family are cultivated to counteract them.

These may appear to be elementary principles and facts, but they are the fundamentals of health which are often forgotten, while some minor though obvious symptom of disease may be given careful attention.

Fortunately there is, after all, in every normal individual an instinctive desire to "be well" and "keep well," and trading on this instinct it should be possible for anyone who has passed through the course of training for medical practice so to amplify and present these fundamental facts that the need for personal effort and care of health will not be disregarded either by individuals or families.

The family unit and daily routine

Although the adult may be regarded as being personally responsible for seeing that the physiological needs of the body are met and that the daily routine of living is adapted to circumstances, the same responsibility cannot rest with the child, whose primary instincts are quite inadequate in face of the varied and artificially created conditions of life which characterise human existence in towns and cities. It is clear, therefore, that the family is the smallest representative unit of the community which must be considered in any scheme for education and training in personal hygiene.

The responsibility for the development of sound personal hygiene in the children rests primarily with the parents, but with the crowding of communities and the development of industry it has been found necessary for individuals and authorities outside the family to share that responsibility and act in an advisory and helpful capacity to those who are in need of information and guidance. Instinct alone may guide an individual in a way of life adapted to his personal needs in primitive surroundings, but intelligent adjustment of the individual's personal life to the needs of others is essential for the health of the family and the community. An appeal to the intelligence of individuals and sympathetic understanding in education and training is essential; the mere statement of rules and recommendations is practically valueless—sound hygiene in the family cannot be achieved by regulations.

In acquiring good habits conscious effort is at first necessary on the part of the child, but as soon as these habits are formed it ceases to be an effort to obey the rules of healthy living. The action of the individual becomes almost reflex in character, or,

in more scientific language, the individual develops conditioned reflexes which are called into action by varied circumstances. The development of these reflex acts in the child at the earliest possible age is the first objective of personal hygiene, and the best safeguard of the health of the individual and, incidentally, of the community as well.

Good habits may help the individual to counteract to some extent the handicap of a poor heredity and certainly of bad environmental conditions at home or at work. Education in personal hygiene is therefore a most important branch of preventive medicine.

If the duties, responsibilities and capabilities of the individuals in a representative family of the artisan class be considered, it is possible to define with some assurance a daily routine for the family which should enable comfort and health to be maintained, provided, of course, that hereditary factors of disease are not present and that economic circumstances permit. The daily routine shown in **Schedule I.** is an attempt to indicate the essential events, requirements and responsibilities associated with the personal hygiene of the various individuals in such a family and of the family as a whole.

The day is the smallest unit of time which needs study, and it is both logical and convenient to deal with the various routine events and recommendations coming within the scope of personal hygiene in the order of the need for their observance from rising in the morning to bedtime and sleep at night. The subject will therefore be dealt with from the point of view of the family and treated as far as possible under the headings shown in Schedule I.

Personal cleanliness. The first general routine event of the day for all members of the family should be the morning wash, in which connection the care of the skin, hair, hands, good and bad soap and hot and cold baths must be considered. The habit of primary importance to health is that of invariably washing the hands before every meal, so that the risk of contaminating the food is minimised. Moreover, it is essential that individuals who prepare the food for the family should realise the need for personal cleanliness. The classical case of "Typhoid Mary," who spread typhoid fever among those for whom she cooked, provides food for thought for dirty and careless housewives. Elsewhere in this book (pp. 355, 386), the subject of food-borne diseases is dealt with, and a brief reference to these should convince any mother of the importance of cultivating the habit in the children of always washing the hands before meals.

Schedule II. sets out in a very condensed form the main facts and recommendations in regard to the care of the skin, hair and hands. The layers of the skin and the various structures are enumerated together with the affections to which they are

liable due to neglect and the rules of personal hygiene which should be observed by the family if skin diseases, infestation and impaired function are to be avoided.

Such subjects as scabies, pediculi and ringworm are dealt with elsewhere (pp. 194, 190, 136), but here it is convenient briefly to discuss the functions of the skin and the means at the disposal of any average family for preventing disease due to personal uncleanliness and neglect.

Functions of the skin. (1) *Protection.* The horny epidermis composed of dead and desquamating cells hardened by the presence of keratin protects the underlying living tissues against immediate injury from mechanical or chemical irritants, either liquid or gaseous, and bacterial invasion, while the pigment in the deeper layers of the skin absorbs radiant energy and hinders or prevents the penetration of biologically active rays of the spectrum which might injure living tissues. The retention of heat in the skin reflexly elicits sweating to prevent too great a rise in temperature.

(2) *Body temperature regulation.* Within limits, the human body possesses the power of subconsciously or automatically increasing or decreasing the heat lost to the external environment, so that by balancing heat production and heat loss the body temperature is kept within normal limits (97°–99° F.) essential for the optimum functioning of physiological processes in the cells of the tissues and organs.

Heat is lost from the skin by radiation if the surroundings are at a lower temperature, by convection and conduction to the cold air in contact with the skin, and by evaporation of sweat from the surface of the skin (see also p. 318). The extent to which heat is lost in each of these ways depends on the temperature of the surrounding objects and the temperature, humidity and movement of the air. (In this connection the reader is referred to p. 418, in which the cooling power of the air and the use of the kata-thermometer are dealt with.) The intelligent use of clothing helps this function of the skin and enables the individual to live in spite of extreme conditions of external heat or cold which the unprotected body could not possibly endure.

(3) *Sensation.* Touch, pain, heat and cold sensations serve to indicate whether the external environment is likely to cause harm to the body, and so give opportunity for subconscious reflex or deliberate but instinctive adaptation in the interests of self-preservation. For example, in order to avoid the harmful effects of excessive chilling, the blood vessels of the skin contract and cut down the rate of heat loss by the body, while in the face of a hot environment the blood vessels dilate and sweating occurs in order to increase heat loss.

(4) *Secretion.* The secretions of the sebaceous and sweat

glands keep the skin pliable, prevent the skin from getting dry and cracking or the hair from becoming brittle, and help to protect the body against heat or cold and the penetration of the skin by water or solutions of chemical irritants.

(5) *Excretion.* The glands in the skin act as excretory organs, and by their activity the body loses fluid, salts and small quantities of certain products of metabolism, urea and lactic acid, while some drugs and harmful substances may also be excreted in this way.

(6) *Respiration.* In man the respiratory function of the skin is of less significance than in such animals as the frog, where gaseous exchange through the skin is an important function. However, in man, if sweating is profuse, considerable quantities of carbon dioxide are eliminated in this way, though little oxygen is absorbed.

(7) *Metabolism.* It has been established that the exposure of the skin to biologically active rays in sunlight or from artificial sources causes changes in the chemical structure of certain substances present in the skin and leads to the formation of vitamin D, which has been isolated and proved to be irradiated ergosterol, a substance closely allied to cholesterol. The absorption of this substance into the body profoundly influences the metabolism of calcium and phosphorus, and enables the normal formation of bone and teeth to proceed and prevents the development of rickets in children, provided the diet is physiologically adequate and well balanced.

The basal metabolic needs of the body in terms of energy are governed by the extent of the surface area of the skin and influenced by such factors as age, sex and environment.

The internal environment. In 1878 Claud Bernard, Professor of Physiology at the Collège de France, in his book "Les Phénomènes de la Vie," pointed out that the maintenance of relatively constant conditions in the internal environment, *i.e.* the immediate surroundings of the actively working cells of the tissues and organs of the body, was essential for the health and proper functioning of all the vital mechanisms of the body as a whole. It is clear from the foregoing brief consideration of its functions that the skin plays a vitally important *rôle* in enabling the body to maintain relatively constant optimum conditions in the internal environment in the face of varied conditions in the external environment. It is known from common experience that even slight fever profoundly affects the body as a whole; a very small variation in the internal environment in respect of the temperature factor affects health and efficiency, while a rise of temperature of 10° F. or less may produce changes in the structure of living protoplasm leading to the death of the cells or derangement of the temperature regulating mechanism and the production of a condition of heat

stroke in the individual. It would be outside the scope of this chapter to deal with such subjects as the blood sugar level, calcium content, viscosity, osmotic pressure or sodium chloride in the blood and body fluids, but the maintenance of relatively constant conditions in respect of these internal environmental factors is of the utmost importance to the healthy working of the body as a whole.

These fundamental conceptions will well repay careful thought, and those interested in the subject are referred to the following publication: *Physiological Reviews*, Vol. 9, No. 3, July, 1929, pp. 399–431, Cannon, W. B.

Baths and soap. Baths are of value for cleansing, stimulating or for their sedative effects in producing bodily relaxation and so aiding recovery and rest after the fatigue caused by strenuous muscular exercise or work. Generally speaking, the skin temperature is in the region of 90° F., and baths above this temperature are classified as warm or hot, while below this temperature they are described as tepid or cold.

TABLE I. BATHS

Description.	Temperature.	Uses and physiological effects.
Cold bath .	Below 65° F.	Stimulating effect on skin followed by increased body heat production in fit individuals. Mechanical cleansing.
Tepid bath.	65°–90° F. .	Mildly stimulating and cleansing.
Warm bath.	90°–98° F. .	Cleansing and sedative. Helps recovery from fatigue.
Hot bath .	Above 98° F.	Stimulating and cleansing. Produces perspiration and dilation of peripheral vessels. May cause rise in body temperature.

In Table I. baths are classified according to their temperature, and their uses and effects on the body are shortly given. It should be remembered, however, that individuals vary very much in their bodily reactions to cold or to very hot baths, and unless the reactions are carefully watched and understood harm may result.

Cold baths or showers should be of short duration unless the individual is actively swimming, and, even then, any sign of blueness or pallor should be taken as an indication that the child or adult should get out of the bath and by vigorous rubbing with towels increase body heat production. Unless

the cold bath is followed by the warm glowing sensation of increased circulation in the skin, more harm than good may be done. In fit individuals increased heat production may last for an hour or more following a cold bath in the morning, but because of the individual variation in reaction to cold, the cold bath is marked $\pm$ in the daily routine given in Schedule I. Care should also be taken in making use of hot baths. For general health and cleanliness the warm bath is of great value, the best time being after the day's work or shortly before bedtime, as the sedative effect produces bodily relaxation as a precursor of rest and sleep.

Unless washing is very frequent it is not possible to keep the skin clean without making use of the solvent and emulsifying action of soap for removing the grease and dirt which may

TABLE II. SOAP

Description.	Composition.	Uses.
Household soap	Sodium or potassium salts of stearic or oleic acids plus excess of free alkali.	Household washing and scrubbing. Harmful to skin.
Toilet soap	Sodium or potassium salts of fatty acids derived from animal or vegetable fats or oils with very little free alkali.	Useful for cleansing skin and usually non-irritating.
Superfatted soap, *e.g.* Castile soap.	Soap in which there is little if any free alkali, and containing a small proportion of lanolin.	Suitable for toilet purposes for rough or sensitive skins.

block up the orifices of the secretory glands. Soaps in general use consist of the sodium or potassium salts of fatty acids derived from animal or vegetable fats and oils. Their cleansing action depends mainly on the solubility of grease and dirt in the presence of alkali, but too much alkali in a soap or the use of soda is harmful to the skin as it enables water to penetrate the cells owing to the solvent or disintegrating action of alkali on keratin. The sodium salts of stearic or oleic acids form hard soaps, while soft soaps are the corresponding salts of potassium. It is doubtful whether the addition of carbolic acid to soaps materially increases their germicidal powers. Soaps made from vegetable fats or oils, *e.g.* coconut oil, are more easily usable in water containing large amounts of mineral salts in

solution. A good soap for toilet purposes should be free from excess alkali or coconut oil and not contain unnecessary ingredients such as resin. It should, moreover, lather freely.

Table II. gives a classification of soaps according to their uses and constituents (see p. 317).

Clothing. The influence of clothing on personal comfort is a matter of common experience, but the effect of clothing on health and vigour is not sufficiently realised. A comfortably clothed individual sitting in still air in a room at approximately 60° F. dry-bulb air temperature and 50 per cent. relative humidity loses some 44 per cent. of excess heat by radiation to the surroundings, 31 per cent. by conduction and convection to the air, and 20 per cent. by evaporation of moisture from the lungs and skin, while the remaining 5 per cent. necessary heat loss is accounted for by the heat required to warm food and inspired air to body temperature. The insulation against excessive heat or cold which clothing affords has enabled man to supplement his natural powers of maintaining an optimum even internal temperature in spite of the external environment and, in particular, such insulation has rendered it possible for races to inhabit cold and temperate countries, the climate of which, according to Huntington, materially increases the energy characteristics of the people who live in them. On the other hand, too much or badly designed clothing tends to depress vitality, for it lessens the need of the body to maintain its temperature by activity and tends to keep the air in contact with the skin stagnant and humid. Too little clothing in cold surroundings, apart from the discomfort felt, necessitates a greater intake of food to supply energy for the increased metabolism of the child or adult, but provided adequate food is available and the child is able to exercise freely, the stimulating effect of cool fresh air and sunlight is generally very beneficial to health. The general trend of fashion is towards freedom of movement and the abolition of tight clothing, but, even so, cases of coddling by over-cautious mothers do occur and should not pass unnoticed. Clothing needs to be adapted to the individual according to age, sex, food supply, occupation and the climate of the living and working environment. It should not provoke sweating in a resting individual, and should permit free evaporation of sweat in the working individual whose excess heat production varies directly with the severity of the muscular work performed. One gramme of water in the sweat when evaporated takes up 585 small calories of heat in being converted into water vapour, and in hot surroundings this may be almost the only means of cooling the body. Heat collapse or heat stroke may develop if this cooling mechanism is not adequate, and in the latter condition sweating may cease owing to failure of the heat-

regulating mechanism. Under such conditions immediate first-aid treatment by drenching the skin with cold water and fanning is necessary.

It should be remembered that, whereas the dry skin is a poor conductor of heat, the wet skin is the reverse. Hence, in cases of asphyxia due to drowning, body heat is lost very rapidly, and, moreover, the patient is liable to become excessively chilled owing to the depression of body functions in addition. In cases of drowning and in asphyxia, generally it is a most important first-aid measure to conserve the body heat by all means possible, *e.g.* dry clothing, windproof clothing or blankets or artificial heating.

In regard to boots, if deformities of the feet are to be avoided, the boot must be adapted to fit the foot, the inner side should be straight and the material waterproof, but not air-proof, as this confines the sweat and produces soft corns. For further information in regard to children's clothing the reader is referred to the Board of Education's Handbook of "Suggestions on Health Education," H.M. Stationery Office, 1939, also to *Lancet*, 4 April, 1936, p. 819, "The Overclothed Boy," Riddell, J.

The usefulness of materials for clothing depends on their physical properties, and the method of weaving. Leonard Hill has classified the properties and functions of clothing materials as follows :—

1. *Heat-retaining powers.* This depends on the air retained in the pores and layers of the materials, for air is a poor conductor of heat. If the thermal conductivity of air be taken as 1, then that of wool is 6, of silk 19, and of cotton and of linen 20. These figures refer to fibre free from air, not to clothing material containing air. The hairy part of fur is 98 per cent. air-space, flannel is 90 per cent. and smooth materials 50 per cent.

2. *Permeability to wind.* This depends, not upon the nature of the fibre forming the garment, but upon the manner of its weaving. Loosely woven thin stuffs are most permeable.

3. *As a source of irritation.* The imbrications of the wool fibres and their elastic projecting nature tend to cause irritation in some individuals.

4. *Influence upon evaporation.* The elasticity of wool fibres tends to keep a woollen garment off the skin and secures a layer of air beneath the garment, helping evaporation and preventing the clinging wetness of a smooth garment. In hot climates smooth clothes—cotton or linen—with high conductivity, are best if they are made loose enough to keep the body well ventilated and to prevent clinging to the skin when the skin is wet with sweat.

5. *Imbibition of water with evolution of heat.* Most dry-clothing fibres imbibe water with evolution of heat. The drier the clothing the more marked the imbibition. When an

individual passes from moist into cold and relatively dry air the evaporation of the water absorbed into the clothing increases the feeling of cold.

6. *Protection against mechanical forces.*

7. *Protection against insolation.* Black material absorbs most visible rays; white reflects most and absorbs least. The absorptive power for dark heat rays, *i.e.* non-visible rays, is about the same for both. Even a thin "zephyr" garment reduces markedly the biological action of ultra-violet rays, while a flannel garment stops it altogether.

8. *Reduction of emission of radiant heat from the skin.* In a room at 15° C., if the emission of radiant heat from the naked skin is reckoned 100, it is reduced to 73 by a wool vest, to 60 with a linen shirt in addition, to 46 with a waistcoat and to 33 with a coat. The emission is greater if the materials are wet owing to the fact that the presence of water in the garment increases the conduction of heat and so causes the temperature of the outer surface to rise.

9. *Protection against wetting.* The more air a material holds the more water will it take up. A woven highly porous woollen material preserves its air-holding properties very largely when wet. Wet materials stick to the skin—flannel and knitted materials least, smooth materials most.

Clothing should be as light as possible, permeable to air, allowing for evaporation, becoming to the least degree wet with sweat, and not clinging to the skin when wet. A cellular structure produced by weaving, whether of wool, cotton or linen, secures the conditions which give the material its warmth, compressibility, porosity, permeability and evaporative power.

(Medical Research Council, Special Report Series, No. 52, 1920; and "Health and Environment," Hill and Campbell, 1925.)

Family food. While the responsibility rests with the "breadwinner," the father, for providing the necessary money to pay the cost of the food required by the family, the housewife is responsible for the actual selection, purchase, preparation and distribution of the food to the individuals according to their respective needs. There is good reason to believe that the maintenance of a state of optimum or normal nutrition in an individual is the most potent factor governing health and resistance to disease, and inasmuch as food is the primary factor which determines the state of nutrition in adults and children, it is of fundamental importance that whoever is responsible for feeding families, or groups of individuals, should have a sound working understanding of the physiological principles which determine the adequacy of diet.

The maintenance of such vital functions as the circulation of the blood, respiration, glandular secretion and body temperature control, demands the continuous liberation of energy

inside the body in the processes comprised by the word "metabolism," which in its general sense means the chemical changes which occur in chemical substances inside the cells and tissues of the body. Basal metabolism has a special meaning in that this term is used to express the extent of metabolism when the body is in a basal condition, namely in a state of complete muscular, nervous and alimentary rest, *i.e.* asleep in bed in the post-absorptive state twelve to eighteen hours after a meal. Under such conditions it has been found that the average healthy adult man produces heat which is lost from the surface of the body at a rate of 40 Calories per square metre of body surface per hour, while the average value for women is slightly less, namely 37 Calories.

The following factors influence the basal metabolism of individuals: age, sex, surface area, state of nutrition, race, external temperature and pathological conditions. All these must be taken into account in deciding whether or not the basal metabolism of an individual is within the normal range of variation from the average of $\pm$ 10 per cent. The basal metabolic rate of an individual is usually expressed as the $\pm$ percentage relation of the basal metabolism to the average level for normal individuals of the same age and sex.

If food is taken, metabolism increases by some 10 per cent., and muscular work necessitates a further increase in direct proportion to the work done. From available data it is possible to construct a daily metabolism balance-sheet for the average adult Englishman as follows:—

Basal metabolism of average man = 40 Calories per square metre per hour; basal metabolism of average woman = 37 Calories per square metre per hour.

Du Bois formula for surface area of man.

$$S = 0{\cdot}007184 \times W^{0{\cdot}425} \times H^{0{\cdot}725}$$

where S = Surface area in square metres.
W = Weight in kilogrammes.
H = Height in centimetres.

Average adult Englishman. Weight 70·3 kilos. Height 171 cm.

Surface area $= 0{\cdot}007184 \times 70{\cdot}3^{0{\cdot}425} \times 171^{0{\cdot}725} = 1{\cdot}772$ square metres.

Basal metabolism of average man

$= 1{\cdot}772 \times 40 = 71$ Calories per hour (asleep in bed).

or $= 71 \times 24 = 1{,}704$ Calories per day.

Definition. A calorie is the amount of heat necessary to raise the temperature of a gramme of water 1° C. from 15° C. to 16° C. A large Calorie or kilocalorie is the heat required to raise the temperature of 1 kilogramme of water 1° C. One Calorie = 1,000 calories. Unless otherwise stated it is the rule

to use the Calorie as the unit when dealing with the energy value of foodstuffs or energy expenditure in metabolism. Thus a food Calorie = a kilocalorie.

Daily requirements of average man

Basal metabolism, 71 Calories per hour when asleep, in bed.

Basal metabolism + 10 per cent. if taking food Basal metabolism + 20 per cent. if up and about	=	71 + 30 per cent. = 92 Calories per hour when awake and about.

Basal metabolism + 1,000 Calories for an eight hours' day moderate muscular work.

Man.

8 hours' sleep at 71	= 568	Calories
8 hours' awake at 92	= 736	,,
8 hours' work at 71 + 1,000 Cals.	= 1,568	
	2,872	

Allowing some additional energy for travelling to and from work, the average man would have a daily energy output of some 3,000 Calories. This energy must be supplied by the food absorbed after digestion.

No food goes to complete digestion and absorption. There is about a 10 per cent. loss with an ordinary mixed diet. Therefore to provide 3,000 net Calories the calorific value of the food must be 3,000 + 10 per cent., *i.e.* 3,300 Calories gross. There will be some loss in cooking and preparation, therefore allow 3,400 Calories for food as purchased (M.R.C. Special Report No. 187, 1933).

Heat values. While carbohydrates and fat are completely oxidised in the body in normal metabolism, protein, the third proximate principle in food, is not completely oxidised, and therefore its physiological heat value is less than the heat produced when 1 gramme of protein is fully oxidised in the bomb calorimeter apparatus used for determining the calorific value of foodstuffs. Moreover, in a mixed diet there is some loss in each foodstuff in the course of digestion. These facts must be taken into account when determining the precise quantities of foodstuffs which need to be consumed in order to yield the actual amount of energy required by the body. The following table gives the figure for calorie values which are commonly used.

	Chemical heat value.	Physiological heat value.	Heat value allowing for loss during digestion of mixed diet.
	Cals.	Cals.	Cals.
1 gm. protein . . .	5·778	4·1	4
1 gm. fat	9·3	9·3	8·9
1 gm. carbohydrate . .	4·1	4·1	4

The following are the Royal Society's figures for the daily food requirement of the average adult Englishman in terms of the three proximate principles in food—protein, fat and carbohydrate :—

	Quantity.	Calorie value.
	gms.	
Protein	100	100 × 4·1 = 410
Fat	100	100 × 9·3 = 930
Carbohydrate . . .	500	500 × 4·1 = 2,050
Total. . .		(Calories) 3,390

This figure of approximately 3,400 Calories is for a man when doing an eight-hour-day moderate muscular work. Fat and carbohydrate as sources of energy are to a certain extent interchangeable, but the above proportions are recommended. The average woman requires from 17 to 20 per cent. less food than man with due increments according to occupation.

(For more detailed information on metabolism, reference should be made to standard text-books on human physiology, *e.g.* Starling's " Principles of Human Physiology," 7th edition, 1936.)

Family coefficients

In a mixed population variations in age, sex, stature and occupation are so wide that it is manifestly impossible to lay down any standard requirement per head. It is, however, possible to adopt some standard individual as the unit and draw up a scale of coefficients expressing the requirements of other individuals in terms of such a unit. As a general rule the average normal adult man is taken as the unit, and the following family coefficient scale, Table III., suggested by Cathcart and Murray in 1931 (M.R.C. Special Report No. 151), is the scale usually adopted in this country. This scale refers to the relative energy requirements of normal average individuals according to age and sex, but it should be remembered that

many factors, particularly occupation and stature, qualify the rigid application to individual cases. If an average sample of a mixed population is assessed according to this scale it is found that 100 individuals would have an equivalent man-value of approximately 83.

TABLE III

FAMILY COEFFICIENTS (CATHCART & MURRAY, 1931)

Man	1·00	Child 8–10 ($9\frac{11}{12}$ths)	0·70
Woman	0·83	,, 6–8 ($7\frac{11}{12}$ths)	0·60
Boy 14+	1·00	,, 3–6 ($5\frac{11}{12}$ths)	0·50
Girl 14+	0·83	,, 2–3 ($2\frac{11}{12}$ths)	0·40
Child 12–14 ($13\frac{11}{12}$ths)	0·90	,, 1–2 ($1\frac{11}{12}$ths)	0·30
,, 10–12 ($11\frac{11}{12}$ths)	0·80	,, 0–1 ($\frac{11}{12}$ths)	0·20
		Adult over 65	0·75

If 3,400 Calories in the food as purchased (*i.e.* 3,000 net Calories in food absorbed) is regarded as a physiologically adequate allowance per man-value, then the requirements in energy for other individuals can be worked out by multiplying 3,400 by the appropriate coefficient. In the report on the Physiological Bases of Nutrition drawn up by the Technical Commission of the Health Committee of the League of Nations, as revised and amplified at the meeting held in Geneva in June, 1936, the following average requirements are laid down, and it is pointed out that all the figures agreed upon are average values and that it is essential they should be interpreted in the light of this fact :—

(*a*) " An adult, male or female, living an ordinary everyday life in a temperate climate and not engaged in manual work, is taken as the basis on which the needs of other age-groups are reckoned. An allowance of 2,400 Calories net * per day is considered adequate to meet the requirements of such an individual."

(*b*) The following supplements for muscular activity should be added to the basic requirements in (*a*).†

Light work	up to	75 Calories per hour of work.
Moderate work	,,	75–150 ,, ,, ,, ,,
Hard work	,,	150–300 ,, ,, ,, ,,
Very hard work	,,	300 Calories and upwards per hour of work.

It is clear that according to this scale a man or woman performing moderate muscular work during an eight-hour working day would need 2,400 + 600, or an average of 3,000 net Calories in the food as assimilated. As shown above, this net Calorie value must be increased to approximately 3,400

* The term " net Calories " refers to the amount of energy available from the food actually assimilated.

† For statistical purposes, to be comparable with previously adopted standards, 600 Calories may be taken as an average supplement for muscular work.

for the food as purchased in order to allow for losses in cooking, preparation and digestion.

The Technical Commission of the League of Nations in the report referred to also put forward revised scales of individual coefficients and protein requirements as follows :—

Age (Years).	Coefficient.	Calories.
1–2	0·35	840
2–3	0·42	1,000
3–5	0·5	1,200
5–7	0·6	1,440
7–9	0·7	1,680
9–11	0·8	1,920
11–12	0·9	2,160
12–15 *	1·0	2,400
15 and upwards	1·0	2,400
Women :		
Pregnant	1·0	2,400
Nursing	1·25	3,000

* The needs of puberty are covered by giving the child of 12–15 years a Calorie allowance corresponding to a coefficient of 1, with appropriate supplements for muscular activity and a protein allowance of 2·5 grammes per kilogramme of body-weight.

"The requirements for babies under one year are difficult to specify except in terms of body-weight ; the following allowances are considered adequate.

Age (Months).	Calories per kilogramme of body-weight.
0–6	100
6–12	90

"The muscular activities characteristic of every healthy child and adolescent necessitate additions to the basic requirements shown above. It is suggested that the activities of children of both sexes from five to eleven years be considered as equivalent to light work, of boys from eleven to fifteen years as moderate work, and of girls from eleven to fifteen upwards as light work. Allowance must also be made for women, whether pregnant or not, engaged in household duties ; these duties have to be reckoned as equivalent to light work for eight hours daily.

"In practice, the protein intake for all adults should not fall below 1 gramme of protein per kilogramme of body-weight. The protein should be derived from a variety of sources, and it is desirable that a part of the protein should be of animal origin. During growth, pregnancy, and lactation, some animal protein is essential, and in the growing period it should form a large proportion of the total protein."

The following allowances of total protein are recommended :-

Age (Years).	Grammes per kilogramme of body-weight.
1–3	3·5
3–5	3·0
5–12	2·5
12–15 *	2·5
15–17	2·0
17–21	1·5
21 and upwards	1·0
Women:	
Pregnant 0–3 months	1·0
4–9 months	1·5
Nursing	2·0

* The needs of puberty are covered by giving the child of 12–15 years a Calorie allowance corresponding to a coefficient of 1, with appropriate supplements for muscular activity and a protein allowance of 2·5 grammes per kilogramme of body-weight.

The Technical Commission commented on the need for fat and the influence of climate on dietary requirements as follows : "Fat must be a constituent of the normal diet but the data at present available do not suffice to permit a precise statement of the quantity required. The high content of vitamins A and/or D in certain fats justifies their use in liberal amounts. In cold climates the energy content of the diet may need to be increased. Where climatic conditions or social customs do not permit of exposure to sunshine, vitamin D should be supplied in the diet."

In 1934 the Ministry of Health issued a Report of a Conference between representatives of the Advisory Committee on Nutrition and the Nutrition Committee of the British Medical Association, in which the following sliding scale of gross Calorie requirements per day was given :—

Individuals.		Calories gross.
Man :	Heavy work	3,400–4,000
	Moderate work	3,000–3,400
	Light work	2,600–3,000
Woman :	Active work	2,800–3,000
	Housewife	2,600–2,800
Boy :	14–18	3,000–3,400
Girl :	14–18	2,800–3,000
Child :	12–14	2,800–3,000
	10–12	2,300–2,800
	8–10	2,000–2,300
	6–8	1,700–2,000
	3–6	1,400–1,700
	2–3	1,100–1,400
	1–2	900–1,100

In considering the various scales it is important always to ascertain whether the figures are gross or net. The gross figures may be understood to apply to the energy value of

foodstuffs as purchased, and the net values to the food assimilated.

While it is usual to assess the general adequacy of diets in terms of Calories, it is essential that the diet should be well balanced, varied and include a sufficiency of vitamin containing foodstuffs, inorganic salts, water and roughage. Having regard to these additional factors it is probably safe to say that the physiological requirements of the average normal adult man performing moderate muscular work would be met by a daily supply of food conforming to the scale and recommendations detailed in Table IV.

TABLE IV

DAILY DIET SCALE FOR AVERAGE MAN

1. Energy . .	3,400 Calories in food as purchased (*i.e.* 3,000 Calories in food as absorbed after digestion).
2. Protein . .	100 gms.: half of animal origin.
3. Fat . . .	100 gms.: not less than 70 gms., some of animal origin.
4. Carbohydrate	500 gms.
5. Inorganic salts	Sodium, potassium, calcium, magnesium, iron, iodine, sulphur, chlorides and phosphates.
6. Vitamins .	A, B_1, B_2, C, D and E.
7. Water .	1,500 c.c.

NOTES

Most of the inorganic constituents and vitamins are automatically supplied in any average well-mixed diet associated with the protein and carbohydrate foodstuffs and dairy produce. The diet should therefore contain a fair proportion of eggs, milk, butter and fresh vegetables and fruits. It should contain a certain quantity of roughage, *e.g.* indigestible residue of vegetables. It must be palatable and varied and free from contamination by pathogenic bacteria, harmful preservatives, or inorganic poisons.

Energy. The daily requirement of the average man in Calories has been dealt with above, but it should be remembered that under cold climatic conditions an additional 300 Calories need to be provided for every 5° C. or 9° F. drop in external temperature. Food shortage is therefore felt more acutely in cold severe weather or under bad housing conditions.

Protein. The main function of protein is to supply nitrogenous material in such a form that it can be digested, absorbed and subsequently utilised for the growth and repair of body tissues and for metabolic processes associated with activity. Protein is the only source of nitrogen, and therefore an essential constituent of the diet, but proteins from animal sources and vegetable sources differ in the nature and proportions of the amino-acids which linked together constitute the protein molecule. Only those amino-acids in which the amino group NH_2 is linked to the carbon atom adjacent to the carboxyl group COOH are of use to the body, and certain amino-acids

are essential for living processes as, for example, lysine for growth, tryptophane for metabolism and life, and cystine—the only known sulphur-containing amino-acid which appears to play an important *rôle* in processes of oxidation in the tissues. Such amino-acids as these are present in proteins derived from animal sources, while some or all may be absent in certain vegetable proteins. It follows, therefore, that animal protein is of more value to the body, *i.e.* possesses a higher biological value, than vegetable proteins, for a smaller quantity of the former would supply the essential needs of the body for nitrogen. For this reason proteins derived from animal sources are described as first-class proteins, while proteins of vegetable origin are regarded as second class. Opinions differ as to the minimum amount of protein required by the average man, and it should be noted that some of the lowest figures, *e.g.* 37 grammes per day, have been obtained using protein of very high biological value, *e.g.* milk protein. If these facts are borne in mind it is clear that there must be a good margin of safety in any diet scale recommended, and this has been taken into account in the scale detailed in Table IV. Generally speaking, it is agreed that approximately 12 per cent. of the total Calories in the diet should be supplied by protein.

Fat. Fats are a very valuable and condensed source of energy for the body and animal fats are of particular value as vehicles for vitamins A and D. Some 30–35 per cent. of the total Calories are supplied by fat in temperate climates, but in cold climates the percentage may be higher because, weight for weight, fat yields 2¼ times as much energy as carbohydrate.

Carbohydrate. Carbohydrates together with fats are the main source of energy for the body, the former providing some 50–60 per cent. of the total Calories. This percentage, however, varies markedly with the individual's occupation and economic circumstances. Industrial workers consume more than twice as much bread (10 lb.) per head per week compared with the average for the general population. This fact was not lost sight of in Great Britain during the War (1914–18) when the rationing of bread was suggested, as a ration scale based on the average consumption would have hit the industrial classes very severely. Bread is the cheapest source of energy, and also a valuable source of protein. To a certain extent fat and carbohydrate are interchangeable, but neither can entirely replace the other. Indeed, there are indications that a certain amount of the one is necessary to secure the proper utilisation of the other. When the proportion of fat is increased to such an extent that less than 10 per cent. of the total energy is supplied by carbohydrates, fat metabolism is upset, acetone appears in the urine and acidosis supervenes. Carbohydrate foodstuffs are protein-sparers—that is they enable the body to satisfy its

nitrogen requirements on a smaller protein intake than would be the case were the carbohydrates replaced by fat.

It would be outside the scope of this section to deal with the digestion, absorption and special metabolism of proteins, fats or carbohydrates and for such information standard text-books on human physiology should be consulted.

Mineral substances. While it is not possible to be dogmatic in regard to the daily amounts of inorganic salts and elements required by the body, it is known that these are essential and that milk, meat and green vegetables are important sources of these constituents and provide them in a form which can be utilised by the body. It is, therefore, of importance that the diet should contain a fair proportion of dairy produce and fresh vegetables.

In Part II. of the Report of the Technical Commission of the Health Committee of the League of Nations, 1936, already referred to, attention is drawn to the fact that the deficiencies of modern diets are usually in the "protective foods," *i.e.* foods which are rich in minerals and vitamins, such as milk, green vegetables, liver, fat, fish, fish oil and fruit. The needs of the pregnant and nursing woman for minerals are dealt with and the following daily requirements are specified: calcium 1·6 grammes, phosphorus 1·7 grammes, iron 10·2 milligrammes. According to Sherman, the daily needs of the average individual for these elements would be met if the diet contained 0·68 gramme calcium, 1·32 grammes phosphorus, 15 milligrammes iron. ("Report on the Physiological Bases of Nutrition," *League of Nations Quarterly Bulletin of the Health Organisation*, Vol. V., No. 3, September, 1936, London, George Allen & Unwin Ltd.; "Nutrition Abstracts and Reviews," Vol. 5, 1935–36, pp. 855–887; Ministry of Health, Advisory Committee on Nutrition, First Report, 1937; *Lancet*, 23 March, 1940, pp. 533–537, 30 March, 1940, pp. 586–590, Cathcart, E. P.; *B.M.J.*, 18 January, 1941, pp. 73–77, "Trends in Nutrition," Orr, J. B.)

Vitamins

A diet may contain the correct proportions of proteins, carbohydrates, fats, mineral matter and water, and yet be lacking in some factors necessary for the maintenance of normal health and metabolism. Research has demonstrated the existence of several such accessory food factors or vitamins, the absence of which from a diet may produce deficiency diseases. The structural formulæ of ten vitamins are known and the syntheses of most of them have been worked out.

The number of vitamins generally recognised is increasing from year to year, but at present only six need be considered in relation to the nutrition of man. The vitamins are divided

into two main groups -fat-soluble vitamins and water-soluble vitamins.

Fat-soluble vitamins. Three fat-soluble vitamins are recognised, known respectively as vitamin A, vitamin D and vitamin E. Vitamin D has been prepared in a pure state, and the name calciferol has been given to the crystalline preparation. Vitamin A has also been obtained in a highly concentrated form, which may represent the pure vitamin itself.

Vitamin A. Cod-liver oil was at one time considered to be the richest source of vitamin A, but other fish-liver and mammalian-liver oils are now known to contain very much larger quantities. The yellow plant pigment carotene can be converted by the animal organism into vitamin A, and must be considered the precursor of vitamin A. The protective effect of vitamin A can therefore be secured by including in the diet either preformed vitamin in the form of animal fats—butter, cream, egg-yolk, liver-oils—or the precursor carotene in the form of yellow or green-coloured vegetables. Vegetable oils themselves are usually devoid of vitamin A. Margarine, which is usually made from vegetable oils, is fortified with vitamins A and D. The amount of vitamin A present in liver oils can be estimated fairly accurately by a colour reaction with antimony trichloride, and with modifications this is applicable to margarines. Vitamin A can be stored in considerable quantities in the tissues (especially the liver), so that young animals will continue to grow for several weeks after receiving food devoid of it. In the absence of vitamin A, the mucous membranes lose some of their power of resisting the entry of infective micro-organisms. The *rôle* of this vitamin in determining the resistance of human beings to naturally occurring infections has not yet been fully worked out. It has recently been shown that vitamin A deficiency may play an important part in the causation of certain types of nerve degeneration, such as those met with in ergotism and intoxications with the lathyrus pea. Mellanby's theory is that the damage to the nerves is caused by overgrowth of bone in vitamin A deficiency. A type of conjunctivitis known as xerophthalmia is recognised as being caused by deficiency of this vitamin. The condition occurs mainly in children and has been investigated more particularly in Denmark. Some 434 cases occurring during the years 1909–20 were examined critically and the deficiency in the diet in these cases was explained by the large consumption of vegetable margarine by the nursing mothers as well as by the extensive use of such articles of food as separated milk, buttermilk, oatmeal gruel and barley gruel in the diets of the children. During 1918 and 1919 no vegetable margarine was manufactured in Denmark;

butter was rationed and was eaten by everyone, with the result that the cases of xerophthalmia fell to a very low level, rising again in 1920 with the reintroduction of vegetable margarine.

The connection between night blindness (nyctalopia) and vitamin A deficiency is now well established and it is known that the condition can be easily and rapidly cured by eating raw liver and that it is the vitamin A present in the liver which is the curative factor. The rod cells of the retina contain visual purple which renders the eye sensitive to light. In a bright light this is bleached but normally regenerates rapidly. In those suffering from night blindness this process is slow. Visual purple is a compound of vitamin A. Cases of the disease can be divided into two groups—those in which the night blindness has proved incurable and those in which it can be cured. Both simple congenital night blindness and the night blindness which characterises the early stages of retinitis pigmentosa come into the first group, while the night blindness sometimes associated with jaundice, with disease of the liver or with malnutrition come into the second. (*Brit. J. Ophthalmology,* Vol. XXIII., No. 3, March, 1939, pp. 161–169, Tansley, Katharine.)

Vitamin D (the antirachitic vitamin). Ergosterol and certain other sterols contained in many foods can be converted into various vitamins D by exposure to ultra-violet light. The vitamin prepared in this way from ergosterol is known as calciferol or vitamin D_2. The chief vitamin D in cod and other liver oils is identical with that prepared by the irradiation of γ-dehydrocholesterol and is known as vitamin D_3. Weight for weight these two products are equally potent for human beings, but vitamin D_2 (calciferol) is almost useless for chickens. Halibut liver oil is from 20 to 30 times as rich in vitamin D_3 as cod-liver oil. (It is about 60 times as rich in vitamin A.) No milk (unless irradiated) is a good source of vitamin D, though milk from cows which have been exposed to sunlight is richer than that from cows kept in stall. It can never be relied upon to provide a sufficiency of vitamin D. The essential effect of this vitamin is to control the calcification of the skeleton, and in its absence rickets is likely to develop in the child and osteomalacia may arise in the adult. It is not known how this vitamin favours the normal utilisation of calcium and phosphorus by the tissues, but it has the same influence over the calcification processes that occur in teeth as over those in bone; hence its *rôle* in the problem of human dental disease. A liberal supply of vitamin D to mothers during gestation and lactation renders their children less susceptible to rickets. There are no quantitative tests based on colour reactions for vitamin D, and biological methods of assay are most commonly employed. The following methods have been advocated to

reduce the incidence of rickets and dental caries by providing sufficient vitamin D :—

(*a*) Education and propaganda on the selection of foodstuffs and family dietaries.

(*b*) Provision of sunlight clinics.

(*c*) Installation of free ultra-violet light treatment centres.

(*d*) Irradiation of milking cows.

(*e*) Irradiation of cow's milk.

(*f*) Provision of halibut-liver and cod-liver oil.

(*g*) Supply of irradiated ergosterol.

Vitamin E. For some time the existence of a vitamin related to the normal functions of reproduction has been suggested, and recent work has established such a factor which is known as vitamin E. It is found in fresh green lettuce, wheat, oats, meat and butter, but not in cod-liver oil. The richest source is the oil extracted from wheat germ. Several substances with vitamin E activity have been prepared, α-tocopheral and β-tocopheral. The natural sources generally contain a mixture of these. As regards solubility it behaves like the fat-soluble vitamins A and D. A deficiency of vitamin E in the diet of female rats causes resorption of fœtuses before the time of delivery, and in male rats this deficiency produces testicular atrophy. It has not yet been definitely proved that this vitamin is essential for normal reproduction in the human species.

Water-soluble vitamins. The water-soluble vitamins include a group of factors which were at one time spoken of as water-soluble vitamin B, and are now referred to as the vitamin B complex, and a separate entity named vitamin C or the anti-scorbutic vitamin.

The number of factors tentatively included in the term **vitamin B complex** is by no means clearly determined. Those whose existence is generally accepted at present are B_1 (aneurin or thiamine), lactoflavin (riboflavin), vitamin B_6 (the rat anti-dermatitis factor), and nicotinic acid (the anti-pellagra factor). In addition there is pantothenic acid, the chick anti-dermatitis factor, well recognised and synthesised but not proved to be necessary for human beings. Vitamin B_1 (aneurin or thiamine) occurs abundantly in yeasts and in the germ of cereals, and less abundantly in liver, egg-yolk, fresh vegetables, pulses meat and milk. It is rather easily destroyed by heat. It has been prepared in a pure crystalline form, both from yeast and from rice polishings. It has also been synthesised. Its absence from a diet results in the development of a characteristic polyneuritis, and is primarily responsible for the appearance of the disease beri-beri among people who subsist largely on a diet of polished rice. A further characteristic effect of vitamin B_1 deficiency is loss of appetite. Definite

symptoms of deficiency of this vitamin are rarely met with among inhabitants of the British Isles. Other B vitamins include factors present in wheat germ, in yeast and in liver extract. A diet deficient in one of these factors produces dermatitis in rats, resembling the dermatitis seen in human cases of pellagra. Pellagra has been successfully treated by means of heated yeast and it has been shown that nicotinic acid can cure black tongue in dogs, a condition which is thought comparable with pellagra in man. Clinical trials have proved that nicotinic acid can also cure the most typical symptoms in the pellagra syndrome. A new product known as "food yeast" comprises the whole range of B vitamins, and contains in microgrammes per gramme aneurin 20, riboflavin 60–80, pantothenic acid 60, and nicotinic acid 400–450, and in addition it contains as much as 50 per cent. of high grade protein approaching meat and fish protein in nutritive value. It is miscible with water, soups, milk and stews, and can also be incorporated in flour. (*Nature*, 10th April, 1943, pp. 406–8, Thaysen, A. C.; *British Medical Journal*, 17th September, 1938, p. 625.)

Vitamin C (the antiscorbutic vitamin). Strong evidence has lately been obtained that vitamin C is identical with a chemical substance which was originally isolated and prepared in a pure crystalline form from the suprarenal glands. This substance is called ascorbic acid and can be obtained from natural foods possessing antiscorbutic activity. The fruit of the green pepper "paprika" is the richest known source, but oranges, lemons and black currants contain an abundant supply; lime juice is a relatively poor source. Green vegetables contain abundance and germinating pulses are fairly rich. Milk contains a small amount, though samples vary, but the milk of cows fed on green pasture is much richer than the milk of those fed on oilcake. The juice of the swede turnip is a valuable source for those who cannot afford expensive fruits, and tomato juice is equally effective; canned tomatoes retain their antiscorbutic activity remarkably well. This vitamin is very sensitive to heat and oxidation, and is destroyed by temperatures well below 100° C. It is more unstable in alkaline than in neutral solutions. Its destruction at high temperatures is less rapid in the absence of oxygen, and a considerable amount of the antiscorbutic properties of tinned fruit is retained when air is excluded during the manufacturing process. The amount of ascorbic acid in a food is determined chemically. With slight modifications the same method may be used to determine the amount of vitamin C in urine and other body fluids.

As milk contains only small amounts of vitamin C and patent infant foods virtually *nil*, orange juice or swede juice

should be given daily to infants, and more especially to those brought up on artificial food. Among adults a continuous diet of bread and tinned meat or fish is productive of scurvy and should be condemned.

Under active service conditions over-cooking of vegetables should be avoided, and in the absence of fresh meat and vegetables germinating pulses or concentrated orange juice should be issued as antiscorbutics, but lime juice is of little or no value.

Various attempts have been made to determine and express in standard units the vitamin content of foodstuffs, and for further information on this aspect of the subject reference may be made to the following publications :—" Vitamins in Theory and Practice," Harris, L. J., Cambridge University Press, 1937 ; " Tables of the Vitamin Content of Human and Animal Foods " (I. and II.), Boas, Fixsen & Roscoe, reprinted from *Nutrition Abstracts and Reviews*, 1937 and 1939 ; " The Biological Standardisation of the Vitamins," Coward, Katharine H., Baillière, Tindall & Cox, Ltd., 1938 ; " The Vitamin Content of Human Foods as affected by processes of Cooking and Canning," Boas, Fixsen & Roscoe, reprinted from *Nutrition Abstracts and Reviews*, 1938 ; " Vitamins and Vitamin Deficiencies," I. Historical and Introductory, Vitamin B_1 and Beri-beri, Harris, L. J., Churchill, Ltd., 1938 ; " The Newer Knowledge of Nutrition," 5th edition, McCollum, E. V., Crent-Keiles, E., and Day, H. G., MacMillan and Co. Ltd., 1939 ; " What are the Vitamins ? " Eddy, W. H., Reinhold Publishing Corpn., 1941 ; " Food, Health, Vitamins," Plimmer, H. A. and V. G., Longmans, Green & Co., 1942 ; *Lancet*, 30th May, 1942, pp. 644–646, Harris, L. J.

Water. (See also p. 402). Wide variations in respect of the daily requirement, intake and output, of water by the individual occur, but for a sedentary worker the daily water balance sheet shown below has been compiled.

WATER BALANCE SHEET FOR SEDENTARY WORKER

Intake.		Output.	
Drink . .	1,450 c.c.	Urine . .	1,500 c.c.
Food . .	800 c.c.	Skin . .	600 c.c.
Oxidation .	350 c.c.	Lungs . .	400 c.c.
		Fæces . .	100 c.c.
	2,600 c.c.		2,600 c.c.

Under tropical conditions when doing hard work not only is the body deprived of water as sweat but there is also a loss of sodium chloride up to as much as 24 grammes a day. In such a case, to maintain a balance, an intake of water up to 2 gallons

a day may be required and the salt deficiency has to be made good.

Assessment of nutrition. Various methods are available: (1) "clinical appearance"—as suggested by the Board of Education (see p. 278); (2) determination of weights and heights for ages in respect of groups of children and comparison of these figures with the standard values; (3) physical performance tests involving the use of a dynamometer and exercise tolerance tests; (4) tests for specific deficiencies—*e.g.*, a photometer test for vitamin A, urine tests for vitamins B_1 and C, and a blood phosphatase test for vitamin D. Iron deficiency may be tested for by hæmoglobin estimation, and hypocalcæmia, giving rise to "spasmophilia," by increased resistance to electrical stimulus. The whole subject is well reviewed by Leslie J. Harris in the *Medical Officer* of the 27th November and 4th, 11th, 18th and 25th December, 1937. (See also *Lancet*, 2nd November, 1940, p. 539, Harris, L. J.)

Family dietaries

In computing the food value of a given diet it is necessary to know the amounts of the various foodstuffs purchased and to calculate how much protein, fat and carbohydrate are present in each item. For this purpose tables of food values have been compiled showing the percentage composition of foodstuffs, the number of grammes protein, fat and carbohydrate present per pound as purchased by the housewife, and the energy value per pound as calculated from the physiological heat values of the proximate principles, namely, protein 4·1, fat 9·3 and carbohydrate 4·1 Calories per gramme respectively.

In practice it has been found desirable in studies of family or institutional dietaries to collect data for the total food purchased and consumed per week, and from the analysis and assessment of the Calorie value of each item to work out the daily diet per man-value in terms of total Calories, percentages and absolute amounts of protein, fat and carbohydrate. This enables the diet to be critically examined from the point of view of adequacy in respect of energy and quantities of the proximate principles. It may be necessary, however, to go further than this and split both protein and fats into their respective classes according to whether they are of animal or vegetable origin, and an inspection of the list of foodstuffs as purchased will reveal errors and omissions in selection of the items, particularly in regard to dairy produce and fresh fruits and vegetables.

Table V. shows the weekly dietary for a family of:—man, wife and three children aged eight, six and two and a half, having an equivalent daily man-value of 3·53. This dietary was

compiled by the Mothers Committee of the North Islington Welfare Centre (North London) and comprised foodstuffs

TABLE V

WEEKLY DIETARY FOR FAMILY: MAN, WIFE, THREE CHILDREN, AGED 8, 6, AND 2½. DAILY MAN-VALUE 3·53. WEEKLY MAN-VALUE 24·71.

	Weight, foodstuff per week.	In grammes. Carbohydrate.	Protein.	Fat.	Calories.
Beef	5 lb.	—	333·5	442·5	5,480
Rabbit	2 lb.	0·8	113·4	40·8	848
Suet	1 lb.	—	5·4	423·2	3,958
Fish (white)	3 lb.	—	194·4	70·2	1,452
Cheese	¾ lb.	10·6	87·5	119·1	1,508·25
Eggs	¾ lb.	4·7	37·7	34·4	494·25
Milk	22 pts.	598·4	411·4	448·8	8,316·0
Butter	1 lb.	—	0·9	376·5	3,503
Lard	½ lb.	—	—	226·8	2,109·5
Dripping	1 lb.	—	—	453·6	4,219
Flour	3 lb.	1,007·1	172·8	18·9	5,016
Bread	26 lb.	5,673·2	850·2	23·4	26,962
Cornflour	¼ lb.	99·3	0·9	0·1	412
Oatmeal	3 lb.	952·5	162·0	117·0	5,658
Rice	1 lb.	362·9	30·8	2·7	1,640
Peas	1½ lb.	428·7	138·2	4·8	2,368·5
Sugar	3 lb.	1,360·8	—	—	5,580·0
Cocoa	¼ lb.	45·7	20·5	30·4	553·8
Jam	2 lb.	629·6	2·8	—	2,592·0
Cabbage	3 lb.	85·8	19·8	1·35	437
Turnips	1 lb.	20·0	5·4	0·45	108
Carrots	1 lb.	43·6	5·4	0·45	205
Lettuce	¼ lb.	2·3	1·1	0·2	21
Potatoes	9 lb.	775·8	67·5	1·8	3,555
Apples	2 lb.	88·8	2·6	1·8	392
Oranges	1 lb.	29·9	2·7	0·4	137
Prunes	1 lb.	153·8	11·3	0·9	685
Weekly totals for family		12,374·3	2,678·2	2,839·6	88,210·0

	Carbohydrate.	Protein.	Fat.	Calories per man-value per day.
Proportion per day per man-value	500·8 g.	108·4 g.	114·9 g.	3,570
Percentage Calories	58	12	30	—

available in the shops in that locality. It corresponds closely to the actual dietaries in well-run households in which the housewife spends her weekly allowance to good advantage. It is true that the diet appears to err on the generous side in Calories, but this might well be needed if the father were engaged on moderately severe muscular work, and the mother and children were active and healthy.

In 1933 the British Medical Association issued a report on family nutrition containing sixteen diet sheets for families of varying size, but although such lists of raw foodstuffs are of value to dieticians and teachers of domestic science, they are of little practical use to housewives on whom the responsibility for the provision of adequate food normally rests. In 1935 the British Medical Association therefore issued a booklet entitled "Family Meals and Catering," which interpreted some of the scientifically planned diets of the 1933 report, in terms of daily menus, shopping lists and recipes for cooking the meals. This form of presentation of diets, deemed adequate on scientific and health grounds, has proved generally acceptable both in the home and in schools where senior girls are taught cooking as part of their elementary school education. (Report of Committee on Nutrition, B.M.A., 1933; "Family Meals and Catering," B.M.A., 1935; "The Doctors' Cookery Book," B.M.A., 1938.)

Value of milk. It has been firmly established by careful investigations both in institutions for children and in the general population that the adequate provision of milk in the daily diet of children materially improves their physical condition and promotes growth and development. According to the Technical Commission appointed by the Health Committee of the League of Nations, already referred to, the pregnant and nursing woman should include 1 litre ($1\frac{3}{4}$ pints) of milk per day in her diet. If milk and green vegetables are absent from the diet of a family, in all probability the diet will not be physiologically adequate, although it may satisfy hunger. These foodstuffs are of particular value in supplying deficiencies in first-class protein, mineral constituents and vitamins, and therefore tend to raise border-line diets to the level of adequacy and safety. In a series of carefully controlled experiments carried out by Corry Mann over a long period in an institution for children, it was demonstrated that the addition of one pint of milk a day to a diet, which by itself satisfied the appetite of growing boys, converted an average gain of 3·85 lb. per boy to 6·98 lb., and an average increase in height from 1·84 inch to 2·63 inches. In addition to this, the general health and vitality of the boys on this extra diet was better than that of the others who were fed on the standard diet of the institution. Experimental work on mice carried out in the London School of Hygiene and Tropical Medicine has shown that diets containing 25 per cent.

of dried separated milk gave the best results as judged by the fertility of breeding does, infrequency of litter-eating and the growth and survival of young mice. Furthermore, mice fed on a diet containing dried skimmed milk in addition to oatmeal and other constituents proved more resistant to natural contact infection with *Bact. typhi-murium* than mice fed on a diet from which the dried skimmed milk was omitted. (*J. Hyg.*, Vol. XXXVII., No. 3, 12 July, 1937, pp. 396-443, and Vol. XXXVIII., No. 4, 10 August, 1938, pp. 424–431; M.R.C. Special Report No. 105, 1926, "Diets for Boys during School Age," Corry Mann, H. C.; "Milk Consumption and the Growth of School Children," Dept. of Health for Scotland, 1930, H.M. Stationery Office; "The Schoolboy, His Nutrition and Development," Friend, G. E., Heffer & Sons, 1935).

Cooking of food. The advantages of cooking outweigh the disadvantages. The chief disadvantage is that coagulable proteins are probably rendered more insoluble in the digestive juices. On the other hand, cooking kills bacteria, and any parasites that may be present—at any rate, in the surface layers. Connective tissue is made more soluble and more easily masticated. The cellulose envelope of starch granules is ruptured and the woody fibre of vegetables is broken up. The main loss in cooking is water, but in roasting a good deal of the fat passes out of the joint. When boiling is employed, the liquor may be used to prepare soup, as otherwise a certain proportion of the nutritive elements may be lost. This applies both to meat and to vegetables. One of the most economical forms of cooking is by casserole. The addition of a moderate amount of flavouring agents and condiments tends to cause a psychic flow of gastric juice, and so to promote digestion and make the food palatable. A certain amount of uncooked food, such as fruit or salads, should be eaten every day. The chemistry of foods and their losses in cooking are dealt with in the M.R.C. Special Reports, No. 187, 1933, and No. 213, 1936.

Cost of living and family budgets

However desirable and important to health the foregoing recommendations in regard to family dietaries may be, it will obviously be impossible for them to be carried out by any family unless adequate money is available for the purchase of the foodstuffs. In this connection it is relevant to consider the essential items in the weekly budget of a family and the relative cost of such items.

The Board of Trade Inquiry in 1904 provided data from which the average percentage distribution of the weekly wages of working-class families was calculated, and it was found that the income was spent as follows:—

Food	60 per cent.
Rent	16 ,, ,,
Clothing	12 ,, ,,
Fuel and light	8 ,, ,,
Other items (washing and cleaning materials, repairs, etc.) . .	4 ,, ,,

The cost of living index figure published each month in the *Ministry of Labour Gazette* is based on current prices in relation to the cost of similar commodities in 1914, which is taken as 100 or basic level. Every month information as to the cost of the items on a list of foodstuffs is obtained from various localities, and from these data the index for food is calculated. In a similar way the indices for rent, clothing, fuel and other items are arrived at, and after ascribing to each an appropriate weight, the cost of living index is ascertained. Thus, according to the *Ministry of Labour Gazette* for September, 1939, the cost of living index, *i.e.* all items included, was 155 or 55 per cent. above the level of 1914. The individual indices were as follows: food 138, rent 162, clothing 207, fuel and light 183, (*Ministry of Labour Gazette*, monthly; Ministry of Labour, "The Cost of Living Index Number: Method of Compilation," H.M. Stationery Office, 1931.)

Owing to the post-war shortage of houses, the cost of building and the exploitation of tenants by landlords who sublet rooms at unreasonable rentals, it is not uncommonly found that an undue proportion of the weekly income of working-class families has to be allocated to paying the rent, and as this is a fixed weekly commitment it necessitates economies in other directions, namely food, clothing or fuel. Various studies on this subject have been made, and it appears that while in certain localities foodstuffs may be bought at much cheaper rates than in others, the minimum cost of physiologically adequate food per man-value per week cannot be safely placed at less than 5*s.* (September, 1933), while it may very well be as much as 6*s.* 6*d.* for families less fortunately situated as regards marketing facilities. It must also be borne in mind that food suitable for children is relatively more costly than for adults, and in families containing a number of children insufficient money would be provided if the sum allocated were based on the man-value equivalent of the family multiplied by the minimum cost of adequate food per man-value. For further information in regard to these matters reference may be made to the following publications: M.R.C. Special Report No. 165, 1932, Cathcart, E. P., and Murray, A. M. T.; "The Minimum Cost of Physiologically Adequate Diets for Working-class Families," Crowden, G. P., *Lancet*, 23 April, 1932; "Diets in Poor Law Children's Homes," Report of the Advisory Committee on Nutrition to

Ministry of Health, 1932; "Povery, Nutrition and the Public Health," M'Gonigle, G. C. M., *Proc. Roy. Soc. Med.*, 24 February, 1933, pp. 677–687; Report on Nutrition, *B.M.J.* (Supplement), 25 November, 1933; "Nutrition and Public Health," Burnet, E., and Aykroyd, W. R., *Quart. Bull., Health Organisation*, League of Nations, Vol. IV., No. 2, June, 1935; League of Nations Report on "The Relation of Nutrition to Health, Agriculture and Economic Policy," 1937.

Action of alcohol on the body. ("Alcohol: Its Action on the Human Organism," H.M. Stationery Office, 1938.)

Alcohol acts mainly on the nervous system. It is really a sedative, and with the possible exception of its action on the respiratory centre, it never stimulates. The control exercised normally by the higher centres is removed, and the result is "decrease of critical self-consciousness." A dose which produces no change in the performance of a simple act will definitely impair the precision of an act demanding greater delicacy and co-ordination. Physiological tests on the competence of motor drivers indicate that driving may be affected by concentrations of alcohol smaller than those needed to affect the behaviour in ordinary clinical tests. In one series half of those experimented on were incapacitated for safe driving by a blood alcohol concentration of 0·05 per cent., while none was capable of driving safely with a concentration exceeding 0·14 per cent. It was considered that 0·18 per cent. was a particularly dangerous concentration since the driver, while not obviously drunk, was likely to do the wrong thing in the event of an emergency. The stimulant action popularly attributed to alcohol is really due to a relaxation of tension. In this way, if worry is likely to interfere with digestion, a little dilute alcohol may aid assimilation of food. Similarly, the narcotic action is useful in sleeplessness. In cases of fainting from pain or fright it is of use in weakening "the excessive check on the heart's action exercised by the nervous centres, and, on account of its sedative influence on the higher levels of the brain, in relieving pain and anxiety."

As a food it is absorbed very rapidly and requires no digestion before entering the blood. It is therefore useful in acute diseases. It is, however, out of place as an ordinary source of energy on account of its harmful action on the higher centres. Furthermore, it cannot be stored in the body to be drawn upon as required. It remains as alcohol in the body till destroyed by combustion. Thus, if it is taken frequently, the tissues are never free from it, and the changes found in chronic alcoholism are produced. Beer has a definite nutritive value due to dextrin and other carbohydrate bodies it contains. More than half the food value, however, of ordinary beer is derived from its alcohol content.

The total consumption of absolute alcohol in Great Britain in 1938 was about 47,124,000 gallons as compared with 47,500,000 gallons in 1937, 41,000,000 gallons in 1934, 52,000,000 gallons in 1926, and about 84,500,000 gallons in 1913. Of the quantity consumed, about 77 per cent. was taken in beer, 12½ per cent. in spirits and 10½ per cent. in wines, etc. The approximate consumption per head was 1·07 gallon in England and Wales, 0·65 gallon in Scotland and 1·02 gallon in Great Britain.

Insurance companies have found that the expectation of life is some three and a half years less for non-abstainers than for total abstainers.

Excretory functions. The provision of suitable and sufficient food and fluids markedly influences the functioning of the excretory mechanism, the regular action of which is essential for health. Normally the first meal of the day, the arrival of food in an empty stomach, initiates the gastro-colic reflex which reminds the individual of the physiological time to defæcate. This reflex should never be disregarded and the cultivation of regular habits in the child in this respect is a matter the importance of which may be judged by the well-known ill-effects on health produced by chronic constipation. The rate of passage of food through the alimentary canal in a healthy individual is such that the undigested residues accumulated during the previous twenty-four hours are in the region of the gut affected by the gastro-colic reflex which is called into action by breakfast. If this reflex is allowed to have its way the whole of the contents of the bowel between the middle of the transverse colon and the anus are got rid of in a series of peristaltic waves and co-ordinated reflex acts in which the fæces pass along the gut while the appropriate sphincters relax to allow their passage. The sudden distension of the rectum causes the desire to defæcate, and damage to the musculature may result if this is not carried out. For adult sedentary workers the occurrence of this reflex act once a day may be adequate, but in children and others living an active open-air life it may occur more frequently, and each time, in the interests of health and fitness, the reflex warning should be answered. The excretory mechanism may be impaired and the normal reflexes weakened if there is too little fluid or fresh vegetables in the diet, the latter providing not only roughage and bulk stimulation, but chemical stimulation of the gut by the partially digested unassimilated breakdown products of cellulose and pentosans (see M.R.C. Special Report, No. 135, 1929). Badly designed water-closets in which the seats are too high may cause mechanical obstruction by postural strain leading to pain and difficulty. These are matters needing careful attention by those responsible for approving the

sanitary arrangements in schools for young children. If proper attention is given to diet, fluids and regularity, constipation can be avoided and the general health of the individual materially improved.

Exercise and muscular work. It is a truism that disuse leads to atrophy and that muscular exercise or manual work not only improves the body musculature, but helps the circulatory, respiratory, digestive, excretory and nervous mechanisms of the body, particularly if such exercise is carried out in the open air. The movement of the open air increases its cooling effect on the body and helps the body to lose the excess heat generated by the exercise. The mechanical efficiency of man, *i.e.* the percentage ratio of external work done to bodily energy expended, depends largely on whether the active muscles are all performing productive work. If some muscles are called into play to maintain posture, the efficiency is naturally less. Even at his best, man is probably not more than 25 per cent. efficient in the mechanical sense. Such work as weight-lifting may be performed at as low an efficiency as 8 per cent., for each effort involves postural displacement and adjustment.

Play and active exercise are essential for the normal mental and physical development of the child. Such exercise or play should be encouraged and not restrained. Up to the age of ten children of both sexes can take the same exercise, but it is held by some authorities that after that age competitive exercises between boys and girls are not desirable. For the ordinary purposes of life it is essential that the strength of the muscles of the trunk, back, legs, arms and shoulders should be maintained, and rational exercises such as walking, running, swimming and jumping, and games such as tennis or golf or the activities associated with camp life, are good for this purpose. Exercise, if properly taken, improves the individual's powers of resisting fatigue. It should not produce excessive fatigue, but normal fatigue which is recovered from during the intervals of rest contributes to health. The sensation of fatigue is a warning to the body to give it a chance to replenish its energy and to repair tissue wastage associated with activity, in other words, to enable the body to adjust the internal environment to the needs of the cells of the tissues and organs.

Leonard Hill says of exercise : "It promotes increased blood flow in and supply of oxygen to all parts of the body, an increased fluid exchange between the tissues and the blood, and facilitation of the removal of waste products. It promotes the metabolism and production of body heat, massages the belly organs, and causes the better absorption and utilisation of the food, so that the bowels are kept open and free from excessive bacterial decomposition and toxic products arising therefrom. Thus the resisting powers of the whole body to disease are kept

up, the brain is swept with a fast flow of well-oxygenated blood, and the mental faculties kept in good condition; the lungs are benefited by the deep breathing resulting from exercise, the ample pulmonary circulation, the evaporation from and flow of lymph through the respiratory membrane; the skin by the enhanced circulation, the evaporation from and flow of lymph through it. The circulation of blood being aided by exercise, freedom of joints and bones is ensured from toxic products of digestion or infection, the blood-forming organ, the red marrow, and the blood being benefited and immunity to infection kept up." The powers given to local authorities under the Physical Training and Recreation Act, 1937, are noted on p. 639. ("Health and Environment," Hill and Campbell, Arnold, 1925; "Muscular Work, Fatigue and Recovery," Crowden, Pitman, London, 1932; "Report of Committee on Physical Education," *B.M.J.* (Supplement), 18 April, 1936.)

Sunlight and open air. While it has long been known that sunlight and life in the open air are very beneficial to health, it is only within recent years that the reactions of the human body to exposure to sun and air have been studied and reliable information obtained. The effects of fresh air and exercise on metabolism have already been referred to, but if, in addition, the human body is exposed to solar radiations, certain reactions occur in the skin which are not only local, but which in their remote action profoundly influence calcium and phosphorus metabolism, and by so doing affect the formation of bones and teeth.

Tanning is a normal reaction of the skin or adaptation of the body to exposure to sunlight. The pigment absorbs excess radiation which might be harmful to the underlying tissues. Pigmentation in the coloured races appears to be an evolutionary adaptation to their environment, for the pigment present in the deeper layers of the epidermis absorbs most of the visible rays and heat rays in sunlight, which penetrate the horny layers of the skin, and the local heating effect produces reflex sweating. The increased heat loss due to sweating prevents local damage to underlying tissues which would result from excessively high temperatures, and at the same time the body as a whole is enabled to maintain its normal temperature in spite of the environment.

Careful study of the reactions of the human skin to radiations from various parts of the solar spectrum has shown that a limited band of radiations outside the visible spectrum in the ultra-violet region produces an inflammatory reaction or erythema of the skin, varying in degree both with the wavelength of the radiations and the duration of exposure.

While the visible portion of the solar spectrum comprises radiations varying in wavelength from 800 millimicrons (*i.e.*

$800\mu\mu$ or 800 millionths of a millimetre) at the red end to approximately $400\mu\mu$ at the violet end, radiations of still shorter wavelength, the actinic or ultra-violet rays are present, and within this band there is a narrow range of wavelengths now classified as biologically active rays because of their specific action on living tissues. A quantitative estimation of the ultra-violet rays from sun and sky may be made by exposing a quartz tube of standard size containing a solution of acetone-methylene blue in some elevated, unobstructed, outdoor position. The bleaching which occurs is determined by comparing the tube with a set of standard tubes. As acetone-methylene blue is bleached to some extent by visible light, a glass tube containing the solution is exposed as well as a quartz tube so that allowance may be made for the bleaching effect due to the visible light. The scale has been determined on a biological basis as each degree represents 2 to 4 times as much radiation as is necessary to produce a slight erythema on the average white skin.

These biologically active rays in sunlight are limited to wavelengths of from 313 to $290\mu\mu$. The unit of measurement commonly used in describing radiations is the Ångström unit, which is 1/10th of a millimicron. Expressed in terms of this unit, the visible spectrum includes radiations from 8,000 to 4,000 Ångström units, the actinic or ultra-violet 4,000 to 2,900, including the biologically active band of rays which ranges from 3,130 to 2,900 Ångström units in wavelength. It is now well established that these biologically active rays in sunlight are of particular value in the treatment of cases of surgical tuberculosis and in some skin diseases.

Radiations of wavelengths still shorter than these are emitted from the sun, but are absorbed by the ozone in the upper layers of the atmosphere before reaching the earth. However, these shorter wavelength rays, which are also biologically active, are produced by the mercury vapour arc, and have been used for many years for the treatment of such conditions as lupus by means of the Finsen light.

The biological activity of various wavelengths is estimated by their power of producing erythema in the skin, and Table VI. shows the relative activity of radiations present in sunlight and emitted by the mercury vapour arc.

It appears that biologically active rays are much more readily absorbed by the superficial layers of the skin than the longer wavelengths, and apart from their local action in producing inflammatory changes leading to increased flow of blood, lymph and lymphocytes to the part, they bring about certain changes in the structure of chemical substances in the skin which lead to the formation of vitamin D which has been isolated and identified as "irradiated ergosterol," and given

TABLE VI

ACTIVITY OF BIOLOGICALLY ACTIVE ULTRA-VIOLET RAYS AS ESTIMATED BY THEIR POWER OF PRODUCING ERYTHEMA OF THE SKIN.

Wavelength in Ångström units.	Skin sensibility per cent.	
3,130	4·5	present in sunlight. (3,130–2,971); present in radiation from mercury vapour arc. (3,130–2,530)
3,020	58·0	
2,971	100·0	
2,890	30·0	
2,800	28·0	
2,650	19·0	
2,530	16·0	

(Hausser and Vahle.)

the name "calciferol." An adequate supply or content in the body of this vitamin appears to be essential for the proper utilisation of calcium and phosphorus in the diet and their subsequent metabolism, which is inseparably associated with the normal formation of bones and teeth. It has been proved that these metabolic functions of the skin brought into play and stimulated by exposure of the body to sunlight may be made use of for the prevention and cure of rickets in children. It must be remembered, however, that the smoky atmosphere of industrial towns (see p. 415) cuts off or absorbs the biologically active rays in sunlight, and other means of supplying the necessary vitamin D (*e.g.* cod-liver oil) must therefore be resorted to in such localities. This fact is a strong argument in favour of smoke abatement.

The indiscriminate use of ultra-violet rays or even of the exposure of the naked body to sunlight may lead to harmful effects, whether the individual is healthy or not. The erythema produced may be too extensive or so intense that damage is done to the skin, and blistering may occur unless the exposure is carefully graded, or administered in the case of the mercury vapour arc in strict accordance with a standard dosage scale. It must, moreover, be remembered that unless the diet provides adequate utilisable calcium and phosphorus, the action of vitamin D will be limited whether supplied in concentrated form or produced by the body itself. The experience in sunlight clinics, such as that of Dr. Rollier at Leysin, teaches that the diet of each individual patient has to be carefully studied, and that individuals vary markedly in their reaction to sunlight, and that very gradual exposure is essential. As a routine the feet only of the patient are exposed on the first day of treatment, and then only for three periods of five minutes. On the second day the legs are exposed, and not until after five days of gradually increasing exposure is the whole body subjected

to the biologically active rays in direct sunlight. ("Heliotherapy," Rollier, A.: Oxford Medical Publications, 2nd edition, 1927.)

Care of the special senses

The eye. The normal development of the eye and the power of vision is largely influenced by the nutrition and general health of the child, while over-strain of the eyes, bad lighting and glare are factors leading to visual defects. "The maximum amount of light should be allowed to come into the house; curtains should be such as can be completely drawn back to expose the whole of the window during the daytime; whenever possible the light should come from a direction to the left of the child, and in any event strong cross-shadows should be avoided; school books should be of a suitable type, and children should be warned against reading badly printed books at home."

"Worried looks, frowning, blinking, face twitching, rubbing eyes, the book held too close to the eyes, and headaches are early signs of eye-strain and call for attention." (Board of Education Handbook of "Suggestions on Health Education," 1939.) It has been recommended that for young children printed letters should not be less than 2·6 mm. in height, nor less than 1·6 mm. for older children. Children should be told of the danger of rubbing their eyes with dirty fingers or using dirty towels, and each child should have its own towel; great care should be taken in removing foreign bodies from the eye, and the use of a corner of a dirty handkerchief for this purpose may lead to infection and loss of sight.

The ear, nose and throat. While the medical inspection of school children leads to the early detection of defects of vision, the same cannot be said in regard to minor defects of hearing which, though they may not amount to a serious educational handicap, may yet be due to causes which materially affect the general health and fitness of the child. Suppuration of the ears, ear discharge, or, as it is popularly termed, "running ears," nose and throat conditions and recurrent colds are not to be lightly regarded by parents. In particular, ear discharge resulting from infection of the middle ear commonly occurs after measles or scarlet fever, and unless it is treated early and correctly middle-ear disease is liable to become chronic and lead not only to permanent deafness, but to impairment of health. Moreover, in later life, any severe strain may cause the condition to flare up and necessitate operative treatment for acute mastoiditis.

Children with discharging ears, or perforations of the ear drums, should not be allowed to bathe and swim in public baths. Such children are particularly liable to infection of the middle ear as a result of the penetration of water. If such

TABLE VII

CAUSES OF REJECTION AND DISCHARGE, 1936–1937

Condition.	Rejected on Medical Examination.	Discharged within Six Months of Enlistment.
	Ratio per 1,000.	
Disease of middle ear . .	51·41	5·33
Loss or decay of many teeth .	23·62	1·07
Defects of the lower extremities	13·48	1·57
Defective vision	23·28	1·72
Flat feet	3·89	0·65
Insufficient weight . . .	8·91	0·05
Valvular disease of the heart .	12·12	0·55
Other diseases of the heart .	11·05	0·31

children are allowed to bathe, they should first have their ears plugged with oiled cotton wool, and even when taking a bath at home such children should be warned not to allow water to enter their ears.

As evidence of the need for increased care of the ears, nose and throat, and for the establishment of routine measures of preventive medicine to ensure that early cases of disease are detected and treated, it is of interest to examine the list of medical causes of rejection of men for the Army, 1936–37. The percentage of recruits rejected on medical examination was 21·87, while the percentage of those discharged as medically unfit within six months of enlistment was 1·95. (War Office Report on the Health of the Army for the Year 1937, H.M. Stationery Office.)

It is worthy of note that one of the commonest causes of rejection of these men on medical grounds was evidence of old or current middle-ear disease. Such men are unfit for service in the Army, for it has been proved that they are particularly liable to break down under the strain of training—a strain which every young man should be fit enough not only to stand, but to profit by. Thus 5·33 men per 1,000 who passed the medical officer were discharged for middle-ear disease within six months of enlistment, this being the major cause of subsequent discharge from the Army during training.

The obvious question to be asked when figures such as these are published is "Did the condition of disease in these men arise before, during or after school age ?" Such a consideration led to an investigation being carried out in 1929 and 1930 into the methods of detecting and the incidence and causes of minor degrees of deafness in school children in the London area. (*Medical Officer*, 13 September, 1930, pp. 113–115.) It was found in that investigation, and has subsequently been confirmed, that

between 6 and 8 per cent. of children of school age show signs of impaired hearing in one or both ears. The returns for the medical inspection of school children (Annual Reports, Chief Medical Officer, Board of Education) had for some years past recorded the incidence of defects of hearing as slightly less than 0·5 per cent., and the Board of Education recorded the fact that "deterioration of hearing may go on for some time before it is noticed." (Handbook of "Suggestions on Health Education," 1939, p. 53.) Of necessity, cases of defective hearing must first be detected before curative measures can be directed at the underlying cause, and in the past the failure in detection of early signs of deafness has been due to the lack of suitable and reliable physiological tests and methods for assessing the hearing of school children. In the investigation referred to above use was made of the American Gramophone Audiometer (see also p. 294), with which it is easily possible to apply the same test to forty children at one time by means of telephones connected with the audiometer, and to pick out those children who need special attention.

Apart from the need for the care of hearing because of its educational significance and the serious handicap of deafness to anyone seeking employment, the fact that the underlying causes of deafness are so often disease, and, as such, causes of ill-health, makes it all the more important that the problem should receive the careful and energetic attention of those responsible for the health of the nation. The problem needs to be approached by definite stages. (1) Detection and measurement of defects by audiometer tests. (2) Medical examination and diagnosis. (3) Medical or surgical treatment. (4) Re-testing each case to assess effect of treatment. (5) Decision by medical and educational authorities in regard to subsequent care of the child. This routine has now been adopted in a number of areas. Defects of speech are commonly associated with defective hearing, and mechanical and electrical hearing-aids have proved of value in the education of the deaf. It cannot be too strongly emphasised that impaired function is often one of the earliest signs of disease, and the early detection of such impairment directs attention to the underlying cause at a stage when appropriate medical treatment stands a good chance of proving successful. (Board of Education Report on Children with Defective Hearing, 1938.)

Care of the teeth. While heredity may play some part in determining whether the teeth of an individual are sound, well developed and healthy, it has been definitely proved that diet and regular cleaning of the teeth are important factors. If the diet contains a sufficiency of dairy produce and green vegetables, the accessory food factors and inorganic constituents necessary for the proper formation of bones and teeth will be provided.

Without careful instruction and encouragement children will not clean their teeth, for they do not realise the necessity for doing so. While it is advisable for teeth to be cleaned twice a day, namely on rising and at bedtime after the last meal, the latter occasion is the more important, and the habit of invariably washing the teeth at bedtime should be cultivated in the child at the earliest possible age. It must be made an invariable rule not to allow any sweets or biscuits to be eaten after the teeth have been cleaned. Each child should have his own tooth brush. The sense of possession tends to encourage a young child to use it. Tooth brushes should be small with soft bristles, and the child needs to be shown how to use the brush by up and down as well as side to side movements. A pinch of salt in a glass of water is a good cleanser for the teeth, while powders such as precipitated chalk are also good provided they are not gritty. Tooth brushes should be thoroughly rinsed after use and allowed to dry. If disinfection is necessary, this can be done by soaking in 1 in 100 carbolic acid or in some other reliable antiseptic for twenty minutes and then thoroughly rinsing the brush in clean water. Much useful and practical information in regard to the care of the teeth in children is given in the Board of Education Handbook of "Suggestions on Health Education, 1939."

Sleep. As previously mentioned, the equilibrium of the daily cycle, work or activity—fatigue and recovery, is essential for health, and sleep is the most important part of the recovery phase. Speaking generally, the duration of sleep is of secondary importance to its depth, and the first two or three hours of sleep are the deepest and most restful. Young children require more sleep than adults in order to give adequate opportunity for processes of growth and development in addition to permitting complete recovery from the fatigue resulting from activity during the day. The approximate figures for the sleep requirements of children are indicated in Schedule I, p. 312. Adults vary considerably in the number of hours of sleep needed for complete recovery, but probably eight hours is a fair estimate of the average requirement. Old people fatigue readily and need more sleep than young adults, because in them the metabolic processes of recovery are slowed down.

During sleep metabolism is some 30 per cent. less than when a person is awake and active. The warmth of bed lessens the need for heat production, and with the dilation of the cutaneous vessels the blood pressure is reduced and the work which the heart has to perform correspondingly lessened. Moreover, the posture of sleep also lessens the work of the heart. Respiration is slower. The muscular system is relaxed and the subconscious maintenance of postural tone is no longer

necessary. On the other hand, digestion proceeds unimpaired, and the body as a whole is given an opportunity of repairing tissue wastage and replenishing its store of energy.

A warm bath, not a hot bath, shortly before bedtime, materially helps restful sleep, and good ventilation in bedrooms and dormitories should be provided by windows open at the top and bottom. Undisturbed sleep is of very great importance to the health of young children, and in noisy localities the children's bedroom should be the quietest room in the house.

SECTION V

FOOD

MILK

THE average composition of various milks is :—

	Cow.	Human.	Goat.	Ewe.	Mare.	Ass.
Specific gravity	1·0316	1·03	1·0305	1·0298	1·0347	1·036
Water per cent.	87·27	87·89	85·71	80·82	90·78	89·64
Casein . .	3·02	1·03	3·20	4·97	1·24	0·67
Albumin . .	0·53	1·26	1·09	1·55	0·75	1·55
Fat . .	3·59	3·30	4·78	6·86	1·21	1·64
Milk sugar .	4·88	6·21	4·46	4·91	5·67	5·99
Ash . .	0·71	0·31	0·76	0·89	0·35	0·51

It will be seen that human milk contains less fat, casein and mineral constituents than cow's milk. Lactalbumin, lactose and iron are, however, greater in amount. The vitamin content is much the same in both, but human milk is probably a better source of vitamin C.

Composition of cow's milk. The composition depends upon a number of factors. The breed of the cow is important. Jersey, Guernsey and Kerry cows give more fat, whereas Shorthorns and Holsteins yield the greatest amount of milk. The average yield of milk per cow lies between 400 and 500 gallons a year, but there is no reason why, with modern farming methods, a good dairy cow should not yield milk at the rate of 600 gallons a year. With rising yields the percentage of lactose shows an increase, but the percentages of fat and non-fatty solids show a decline. It would be wiser perhaps to judge the milking performance of a cow rather upon the total energy yield of the milk. The age of the cow has more effect on the yield than on the composition of the milk, the yield increasing up to about eight years and then declining. A cow normally produces her first calf at from two and a quarter to three years of age, and the average milking life of cows is from four and a half to five years. Morning milk usually contains less fat than evening milk—this is due to the longer night interval between milkings. The last milk drawn from the udder, the "strippings," may contain as much as 9 per cent. of fat whereas the fore milk may contain as little as 0·5 per cent. A properly balanced ration should be provided for dairy cows ; with an inadequate ration the cow will draw on her body tissues to rectify the deficiency and the

result will ultimately be a reduction in the yield of milk. A cow needs first of all what is known as a "maintenance ration," and over and above that should have a special "milk ration," the object of which is to increase the yield of milk. As a rule winter milk is richer in fat and non-fatty solids than summer milk, but the winter yield of milk is somewhat lower. There may be considerable day-to-day variation in the composition of the milk of any one cow, and even in a herd of thirty to thirty-five cows the content of fat and non-fatty solids has been shown to vary as much as 1 per cent.

Milk has a density of 1·029–1·033; it is slightly acid when freshly drawn due to the presence of acid phosphates, citrates, carbon dioxide and casein. This acidity is equal to 0·08–0·23 per cent. expressed as lactic acid. To this natural acidity is added subsequently the acidity due to souring or the formation of lactic acid resulting from the fermentation of lactose. When the acidity reaches 0·4 per cent. in terms of lactic acid a sour taste may be detected and at 0·7 per cent. milk curdles owing to the precipitation of the proteins. Such souring can be controlled by keeping the bacterial content of the milk as low as possible and by cooling the milk below 50° F. When about 1 per cent. of lactic acid has been produced bacterial action ceases. Lactose or milk sugar ($C_{12}H_{22}O_{11}$) is used largely in the preparation of infant foods. It is recovered in commercial processes from the whey of milk. Rennet, which is a saline extract of an enzyme, rennin, secreted in the fourth stomach of the young calf, will also curdle milk, the optimum temperature for the reaction being about 104° F. The coagulum consists of a combination of calcium and casein, with fat, mineral matter and whey mechanically included. Whey, if produced from separated milk, contains 93–94 per cent. of water, a trace of fat, about 1 per cent. of protein, 4·8–5·5 per cent. of lactose and from 0·5–0·65 per cent. of ash. Human milk is not so much affected by acids as is cow's; this accounts for the more flocculent clot formed in an infant's stomach with human milk as compared with the coarse clot of cow's milk.

Milk proteins include casein (about 3 per cent.)—a phosphoproteid which exists in combination with calcium as a fine colloidal suspension; lactalbumin about 0·5 per cent. and lactoglobulin about 0·03 per cent. Colostrum is the name given to the secretion of a cow for the first seven days after calving. It contains a higher proportion of albumin and globulin and a lower percentage of lactose.

Milk fat amounts to about 3·5 per cent. and exists in milk as globules from 0·1μ to 10μ in size. If milk is allowed to stand for about eight hours some 60 per cent. of the fat will rise to the surface. With the cream rises most of the colouring matter

of milk which is now known to be carotene. This substance is derived from vegetable food, especially young grass, and is the source of the vitamin A content of cow's milk. Another colouring matter, xanthophyll, is also present in milk, but it has, so far as is known, no connection with vitamin A. When the fat is removed by centrifuge, only about 0·15 per cent. remains in the milk. Thick cream contains some 56 per cent. of fat and thin cream some 29 per cent. Reconstituted cream is made by mechanical agitation of good unsalted butter in separated milk or a solution of dried separated milk and water. On account of the keeping qualities of the raw materials the use of this reconstituted cream is very popular in hotels and on ships. The Food and Drugs Act, 1938, requires receptacles containing such cream to be labelled with the words "Artificial cream" (see p. 586). Even distribution of fat throughout milk may be obtained by the process of homogenisation. In this process the milk, usually at a temperature of from 140° to 155° F., is compressed in a cylinder at 2,000–3,000 lb. pressure per square inch. This pressure releases an agate valve in the cylinder and as the milk is forced through the narrow space between the valve and the valve seating the fat globules are burst. In homogenised milk the fat will not rise as cream, and, even after being centrifuged, such milk retains over 70 per cent. of its fat.

The vitamin value of cow's milk varies greatly according to the diet and management of the cow; hence such infants as are fed almost wholly on cow's milk should be given supplementary vitamin-containing food. The vitamin A content depends on the amount of fresh green food the cow receives and the vitamin D content largely on the exposure of the animal to sunlight. The content of both these vitamins can be much increased by adding cod-liver oil to the cow's food. Milk is of little account as a source of vitamin B_1, but is one of the richest of the foods containing other vitamin B factors. The vitamin C content is negligible, considered from the standpoint of a child's requirements. After pasteurisation it is slightly reduced and re-heating still further reduces the residual amount.

The ash of milk amounts usually to about 0·75 per cent. The chlorides of sodium and potassium, citrate of calcium, potassium phosphate and a small quantity of soluble calcium phosphate are present in solution, while the bulk of the phosphates of calcium and magnesium are in colloidal form. Small quantities of copper, manganese and iodine are also present; both human and cow's milk have a low iron content (Medical Research Council Report No. 157, 1931).

Under the Sale of Milk Regulations, 1901, milk containing less than 3 per cent. of fat or 8·5 per cent. of milk solids other than fat is presumed to have been adulterated. The Sale of

Milk Regulations, 1912, fixed the figure of solids other than fat in skimmed or separated milk at 8·7 per cent. The Food and Drugs Act, 1938, prohibits the addition to milk of colouring matter or water, or any dried or condensed milk or any fluid constituted therefrom, or any skimmed or separated milk. The P.H. (Preservatives, etc., in Food) Regulations, 1925 to 1940, prohibit the addition of preservatives of any kind to milk and of any thickening substance, save cane or beet sugar, to cream. Adulteration by the addition of water or by the abstraction of fat is much less common now than some years ago. The former is indicated by the reduction of the non-fatty solids below the standard 8·5 per cent. and the latter by the lowering of the fat figure below the standard 3 per cent. The cryoscopic or freezing-point method may be employed for the detection of added water in milk. The freezing point of normal milk has been found to vary within narrow limits, lying between $-0{\cdot}530^\circ$ C. and $-0{\cdot}566^\circ$ C. Any addition of extraneous water raises the freezing point of the milk in proportion to the amount of water added. The method, perfected by Hortvet and commonly known as the Hortvet test, requires a standardised cryoscope. The milk samples should be as fresh as possible and should not show acidity above 0·15 per cent. in terms of lactic acid. In 1938 the number of milk samples analysed by public analysts in England was 80,025 and a percentage of 7·7 was reported as adulterated.

Milk drawn aseptically from the udder of a healthy cow contains very few bacteria, but, as it forms an excellent medium for the growth of organisms and as the opportunities for contamination are unfortunately only too numerous, millions of bacteria per cubic centimetre of milk may be found within a few hours of milking unless every possible precaution is taken. These bacteria gain an entrance to milk either as a result of some disease process in the cow or of dirty external conditions. Top milk usually contains many times the number of bacteria found in the remaining portion of the milk. The aim of all those concerned with the public health is to see that consumers are provided not only with a clean milk, but also with a safe milk, that is, a milk free from pathogenic organisms. It must not be forgotten that a milk produced under thoroughly clean conditions and showing a low bacterial count may yet be infected with the organisms of such diseases as tuberculosis, scarlet fever, septic sore throat, diphtheria, undulant fever, foot and mouth disease, enteric fever, dysentery, cholera and epidemic diarrhœa (*J. of the Soc. of Chemical Industry*, 24 November, 1933 : "Disease-producing Organisms in Milk," Minett and Pullinger ; *Bulletin of the Health Organisation of the League of Nations*, 1937, Vol. VI., pp. 372–504, "The Milk Problem.")

Milk-borne disease

That milk may convey various types of infection is now well recognised. In the U.S.A. between 1881 and 1926 nearly 800 milk-borne outbreaks were recorded, of which 613 were of typhoid fever. These figures take no account of bovine tuberculosis or of diarrhœa in infants, much of which is thought to be due to infected milk. Ordinary raw milk, or its products, was incriminated in 179 outbreaks, "pasteurised" milk or its products in twenty-nine of these, certified milk in three, while in 356 the character of the incriminated supply was not stated. Ice-cream was involved in thirty-six outbreaks, butter in three and cheese in four. Between 1923 and 1938 the number of milk-borne outbreaks reported was 681.

In Great Britain during the years 1912–37 there were 113 recorded outbreaks of milk-borne disease affecting about 14,000 persons. These figures refer only to outbreaks traced to liquid milk or cream and do not include the large number for which ice-cream, cream cakes or cheese have been responsible. During the same time about 65,000 persons in England

MILK-BORNE EPIDEMICS IN ENGLAND AND WALES, 1933–1937.

Place.	Year.	Disease.	Notifications.	Deaths.
Hyde . .	1933	Scarlet fever.	43	4
W. Hartlepool	1933	Para-typhoid B.	24	1
Epping U.D., R.D. and district.	1931	Para-typhoid B.	312	8
Epping U.D. and R.D.	1933	Para-typhoid B.	22	None
Chelmsford B. and R.D.	1935	Scarlet fever.	487	6
Eton R.D. .	1935	Scarlet fever.	100	2
Kettering U.D. and surrounding district	1936	Enteric	9 cases in U.D. and 23 in district.	1 death among the 9 U.D. cases.
Bournemouth, Poole, and Christchurch.	1936	Enteric	718	51 among the residents.
Doncaster.	1936	Scarlet fever and tonsilitis.	135 cases of scarlet fever, 229 "sore-throat."	2 deaths "definitely associated with the outbreak."
Wilton (Wilts)	1936	Gastro-enteritis. (Dublin type.)	About 100	None

and Wales died of tuberculosis of bovine origin, while an unascertained number, probably several thousands, suffered from undulant fever due to infection with *Br. abortus*. In addition a proportion of the 190,000 deaths from epidemic summer diarrhœa in England and Wales which occurred in infants under two years of age during this period must be attributed to the same cause.

The characteristics of milk-borne outbreaks are briefly :—

1. The outbreak is often explosive in onset, but not always so.
2. A high percentage of cases obtain their milk from the same producer or distributor.
3. Cases occur among users of milk, ice-cream, etc.
4. Multiple simultaneous cases often occur in the same household.

SUMMARY OF 612 MILK-BORNE OUTBREAKS IN U.S.A. (1908–26).

Disease.	Number of outbreaks.	Number of cases (incomplete).	Number of deaths (incomplete).
Typhoid fever	479	14,968	219
Paratyphoid	7	434	15
Diarrhœa and dysentery	6	92	5
Septic sore throat	42	21,045	139
Scarlet fever	40	3,939	20
Diphtheria	26	971	7
Miscellaneous diseases	12	878	5
Total	612	42,327	410

5. The incubation period of the disease may be shortened.
6. When the infected milk supply is stopped, the outbreak subsides.

It has frequently been stated that the incidence of milk-borne disease falls most heavily on women and children, but Picken has pointed out (*B.M.J.*, 27 June, 1936, p. 1291), that the information available seems to show that in milk-borne epidemics of scarlet fever and diphtheria children actually figure less prominently than usual, and that there is probably no differential incidence in adult females. When the alimentary infections are considered there appears to be some ground for thinking that typhoid may be discovered among a higher proportion of young persons than usual when milk is the source of infection, and that women, too, may suffer more ; but these features are insufficiently prominent to distinguish milk epidemics—at least, from those which are water-borne. In epidemics of paratyphoid and dysentery there is no definite

evidence in favour of the prevailing view. (See also *Lancet*, 5 September, 1936, p. 589, "Enteric Fever in Milk-borne and Water-borne Epidemics—a Comparison of Age and Sex Incidence," Hill and Mitra.)

Tuberculosis of bovine origin. It is estimated that some 40 per cent. of dairy cows in this country would give a positive reaction to the double intradermal tuberculin test. This test consists of the intradermal injection of a sensitising dose of 0·1 c.c. of old tuberculin into a shaved area about the middle of the neck of the animal, followed forty-eight hours later by a second intradermal injection of a similar amount of old tuberculin into the middle of the same area. In a positive reactor there will be a hot, tender, œdematous, swelling at the site of the inoculation observable twenty-four hours after the second injection and usually persisting for much longer (Memorandum on the Double Intradermal Test in Cattle, H.M. Stationery Office; "Tuberculin Tests in Cattle," Buxton, J. B., and Glover, R. E. (Rept. No. 4, Agric. Res. Coun., 1939). About 0·5 per cent. of milch cows suffer from udder tuberculosis and are excreting tubercle bacilli in their milk. Abattoir figures indicate that about 40 per cent. of cows slaughtered show naked eye lesions of tuberculosis. The proportion of raw market milk containing living tubercle bacilli varies in different parts of the country from 2 to 13 per cent. with an average figure of 6·7 per cent. In 1938 the figure in London for churn milk was 7·5 per cent. Bulked milk brought to London in tanks shows a high percentage of infection—in 1934, tubercle bacilli were found in 8 out of 37 samples examined (see p. 365).

The bovine type of *Myco. tuberculosis* has its natural habitat in cattle, but it is frequently found in man and in pigs. Infection of man with the bovine type occurs mainly by the alimentary tract and the lesions are chiefly non-pulmonary (see p. 80). While the annual death rate from tuberculosis has diminished considerably during the past eighty years, the fall in the non-pulmonary rate has been much more marked than the fall in the pulmonary. Thus the non-pulmonary death rate in 1938 was only 23 per cent. of the death rate in 1901, whereas the pulmonary death rate in 1938 was 37 per cent. of that in 1901. "It is estimated that about 6 per cent. of all deaths from tuberculosis in England and Wales are caused by the bovine type of organism, that about 2,000 deaths, mostly in children, occur annually from this cause, that at least 4,000 fresh cases of bovine infection develop each year and that an immense amount of suffering, invalidity and often permanent deformity is caused by this bacillus." About two-thirds of the deaths occur in children under the age of fifteen years, the disease affecting mainly the abdomen or the nervous system or being disseminated in character. An

excellent summary of the position will be found in the Ministry of Health Report No. 63, 1931; "A Survey of Tuberculosis of Bovine Origin in Great Britain," (People's League of Health, 1932); Medical Research Council Report No. 184, 1933; *B.M.J.*, 18 November, 1933, p. 905, Savage.

Typhoid and the **paratyphoid fevers** are frequently spread through milk supplies. The organisms may multiply in milk without altering in any way its taste or appearance. Infection is usually due to the presence of a carrier or missed case at some stage in the production or handling of milk. It may also be due to the use of infected water for washing utensils or for the fraudulent dilution of the milk. The most serious recent outbreaks of milk-borne typhoid fever occurred in Montreal in 1927, in Bournemouth in 1936 (Ministry of Health Report No. 81, 1937), and in Algiers in 1937 (*Bull. Acad. Méd.*, Vol. 120, 1938, p. 205); in 1931 over 300 cases of paratyphoid fever in and around Epping were traced to a milk supply infected apparently by one of the milkers. An outbreak of paratyphoid fever due to infected cream occurred in Bristol in 1940. (See Supplementary Report to the Local Government Board, 1874, pp. 103–136; Ministry of Health Reports No. 30, 1925, and No. 53, 1928; *Public Health*, March, 1930, pp. 168–174; *Lancet*, 21st December, 1940, pp. 778, 779, Davies, Cooper & Wiseman.) The first recorded outbreak of infectious disease due to a milk supply was an epidemic of typhoid fever in Penrith in 1857 (*B.M.J.*, 1870, p. 623, Taylor).

Dysentery may also be spread in this manner (*J. of Hyg.*, Vol. 21, 1923, p. 451; Vol. 25, 1926, p. 434; and Vol. 26, 1927, p. 271; and Ministry of Health Report No. 20, 1923).

Epidemic or summer diarrhœa may be spread by milk which has been improperly stored or handled. Infection enters the milk usually by way of dust or flies. *Cholera* may also be transmitted in the same manner, but here infected water may also play a part. An outbreak of gastro-enteritis due to the *Salmonella* group, type "Dublin," and conveyed by milk occurred in Wilton in 1936. The organism was found in large quantities in the dung, but not in the milk, of one cow in the implicated herd (Ministry of Health Report No 82, 1938).

Diphtheria may be due to infection of a milk supply by a case or carrier, and it is thought that sores on the teats of a cow may be secondarily infected with diphtheria bacilli (Report, Chief Medical Officer, Local Government Board, 1913–14, Appendix, p. 30).

Infections due to hæmolytic streptococci may take the form either of scarlet fever (often without any skin eruption) or of septic sore throat. The organisms may come either from the throat of a person handling the milk, in which case only small numbers of persons are likely to be infected, or from the

infected udder of a cow when large epidemics may occur. Mastitis, which is a common disease of cows, is ordinarily due to a type of streptococcus that is non-pathogenic to man. It is only when the udder is infected with a strain of human type that the milk becomes dangerous. Outbreaks of milk-borne streptococcal infection are unfortunately fairly common—early epidemics were recorded in the Eleventh Report, Chief Medical Officer, Local Government Board, 1881, p. 60, and in a special Local Government Board Report in 1886 (Hendon). More recent outbreaks have been reported in Massachusetts in 1928, Brighton and Hove in 1929, Chelmsford and Copenhagen in 1935, Doncaster in 1936, Vejle (Jutland) in 1937 and R[illegible] in 1938 (*Medical Officer*, 18 January, 1936, p. 25, and 16 September, 1939, p. 117; *Lancet*, 26 September, 1936, p. 756; *J. of Hyg.*, Vol. 39, 1939, p. 51).

Undulant fever due to *Br. abortus* or *Br. melitensis* is conveyed by the milk of infected cows or goats. It is probable that the amount of such infection in England has been seriously underestimated in the past. The occurrence of mild epidemics has been reported by numerous workers in Canada, in the United States and elsewhere. A mild epidemic occurred in a boys' school in this country in 1939. (See also p. 127.)

In outbreaks of **foot and mouth disease** in animals, some cases showing fever, sore throat and vesicles in the mouth have occurred among human beings who have consumed milk from infected animals. (*B.M.J.*, 13th February, 1943, p. 189, Dlugosz, H.)

The whole subject of milk-borne disease is reviewed in "The Pasteurization of Milk," Wilson, G. S., Edward Arnold & Co., 1942.

Administrative problems of milk supply

The first serious attempt to regulate dairies and cowsheds was made in 1879 when a Dairies, Cowsheds and Milkshops Order was issued by the Privy Council under powers given them in the Contagious Diseases (Animals) Act. This and a subsequent Order of 1885 dealt with registration of dairymen, the sanitation of dairies and cowsheds and similar matters. No more legislation regarding milk supply was passed till the Milk and Dairies (Consolidation) Act, 1915, which, however, did not come into operation till 1925. In the meantime certain amendments of this Act appeared desirable and these were embodied in the Milk and Dairies (Amendment) Act, 1922. Both these Acts were repealed by the Food and Drugs Act, 1938. Powers were given in these Acts to make orders (really regulations) regarding the production and distribution of milk and regarding milk sold under special designations (tuberculin tested, accredited and pasteurised, p. 612). The Acts also

made provision for the registration of dairies and dairymen and for stopping supplies of tuberculous milk, and prohibited the addition of colouring and other unsuitable matters to milk. These Acts and Orders were the contribution of the Local Government Board and of the Ministry of Health towards securing a cleaner and safer milk supply and local health authorities were the bodies responsible for giving effect to their provisions.

The Minister of Agriculture and Fisheries issued the Tuberculosis Order, 1925 (now 1938), which provided for the notification and slaughter of bovines suffering from open or advanced tuberculosis (p. 616) and later introduced a scheme for the creation of " Attested Herds "—herds free from tuberculosis as shown by the intradermal tuberculin test (p. 366).

Of late years Government has taken an increasingly active interest in the production and sale of milk. As a result of a report of the Commission on the Re-organisation of the Milk Trade, a milk marketing scheme was introduced in 1933. Under this scheme Milk Marketing Boards, representing mainly the producers, were established with which all producers of milk have to be registered. No producer can sell milk unless he is registered with the Board and he can sell milk only in compliance with the conditions laid down by the Board. The Board is a party to all wholesale contracts for the sale of milk. This ensures that individual producers cannot undercut the market and that producers get a guaranteed price for their milk—one price for milk sold for liquid consumption and another, lower, price for milk sold for manufacturing purposes. Producer-retailers constitute about two-fifths of all producers but they produce only about one-sixth of all liquid milk sold retail. They are not required, of course, to sell milk through the Board but, like all other registered producers, they have to make a contribution to the Board of a certain sum for every gallon of milk sold.

As an inducement to farmers to produce milk in a more cleanly fashion the Milk Marketing Board established a roll of " accredited producers." Under this scheme all producers who comply with the conditions for " accredited milk " laid down in the Milk (Special Designations) Regulations, 1936 to 1942, receive from a pool, contributed to by all producers, a bonus of 1*d*. per gallon of milk sold. The " accredited" standard is one which every farmer should be required to reach. There is no guarantee, unfortunately, that such milk is free from tubercle bacilli or other infective organisms, and in all probability milk from accredited herds is as likely as ungraded milk to contain tubercle bacilli. The Accredited Milk Scheme was meant to give farmers a more scientific outlook on milk production and gradually to draw them towards tuberculin tested milk pro-

cedure. Even if the herds do not contain tuberculous animals, the *infrequent veterinary inspections give no guarantee that* the output in bulk is not contaminated.

The Milk Acts, 1934 to 1938, authorised for a limited period the payment of Exchequer contributions towards (1) means of increasing the consumption of milk, and (2) measures for improving the quality of milk. Under (1) the "Milk in Schools" Scheme was introduced whereby children could obtain one-third pint of milk daily in schools for ½*d*. The milk was provided through the Milk Marketing Boards and its source and quality had to be approved by the medical officer of health. On 31st July, 1939, a scheme prepared by the Milk Marketing Board and approved by the Minister of Agriculture and Fisheries came into operation for providing liquid milk at reduced prices (1s. 4*d*. per gallon) to local authorities for the purposes of their maternity and child welfare arrangements. Under (2) the Ministry of Agriculture and Fisheries' scheme for "Attested Herds" received financial assistance.

The average daily consumption of milk in Great Britain during 1937–38 was below that in Denmark, New Zealand and the United States of America and less than half of that in Norway, Switzerland and Canada. The consumption of butter was higher than in any other European country and the total dairy produce consumed in Great Britain was up to the equivalent of almost 2 pints a day. The average daily consumption of liquid milk per head in England and Wales in 1937–38 was 0·42 pint.

The Agriculture Act, 1937, provided that all veterinary work in connection with Milk and Dairies Orders, specially designated milk and attested herds should be carried out by veterinary inspectors of the Ministry of Agriculture and Fisheries. The services of these inspectors may be used by local authorities, on payment, in respect of their functions relating to public health. The Act also authorised special payments in connection with the eradication of tuberculosis from herds.

The foregoing paragraphs describe the position as it existed before 1939 when the Ministry of Food was established as a war-time measure. This Ministry has taken over the Milk Marketing Board and is now responsible for the distribution of milk throughout the country.

In 1942 a Government "Memorandum on Milk Policy" (Cmd. 6362) was issued which, amongst other things, intimated that the price for milk paid by the Ministry of Food to milk producers would vary according to the quality of the milk as revealed by a test of the milk itself. Milk will be classified by the results of a special test into "Market," "Salvage," and "Rejected." "Salvage" milk will receive a lower price than

"Market" and no price will be paid for "Rejected" milk. This procedure was necessary on account of the progressive deterioration in the keeping qualities of milk during the war years. (National Milk Testing and Advisory Scheme, Min. of Health Circulars 2669, July, 1942, and 2761, February, 1943.)

In 1943 another Government White Paper (Cmd. 6454) was introduced dealing with "Measures to Improve the Quality of the Nation's Milk Supply." This Paper states that in the Government's view every herd should be inspected by a Government veterinary officer at least once a year. As such a course is not possible at the present time, it is proposed that tuberculin tested herds will be inspected, as at present, once in every six months. Accredited herds will be inspected at least once a year where the milk is subject to adequate heat treatment. Where the milk is not so treated, the herd will be inspected, as at present, once in every three months, unless the herd is attested, in which case it will be inspected once in every six months. All other herds will be inspected once a year where the milk is heat-treated and twice a year where the milk is not heat-treated, with additional inspections of those herds with a bad disease history.

It is the intention of the Government to ask Parliament to transfer to the Ministry of Agriculture and Fisheries the functions of local authorities relating to the conditions under which milk, including designated milk, is produced on the farm.

In order to encourage the sale of T.T. milk, the premium paid to producers will be raised and T.T. milk will be sold to the public at a price only slightly in excess of that paid for ordinary milk. It is intended in addition that the Ministry of Food should be empowered by regulation to make it an offence to sell milk by retail in any area which he may schedule unless either :—

(i) it is heat-treated as defined by Order ; or
(ii) it is lawfully sold as T.T. milk ; or
(iii) it is accredited milk sold by a retailer (whether producer-retailer or dairyman) who sells the milk of a single accredited herd.

Milk will be regarded as heat-treated if it satisfies the phosphatase test for adequate heat treatment, supplemented by a methylene blue test for keeping quality, as prescribed by the Minister of Health.

In cases where the trade itself cannot instal and operate pasteurising plant, local authorities will be empowered to do so.

Modern methods of securing clean milk ("Modern Milk Production," Bulletin No. 52, Ministry of Agriculture and Fisheries, 1937).

1. *Cow-houses.* A single-range house is sufficient if there are not more than fifteen cows. Such a house should have a

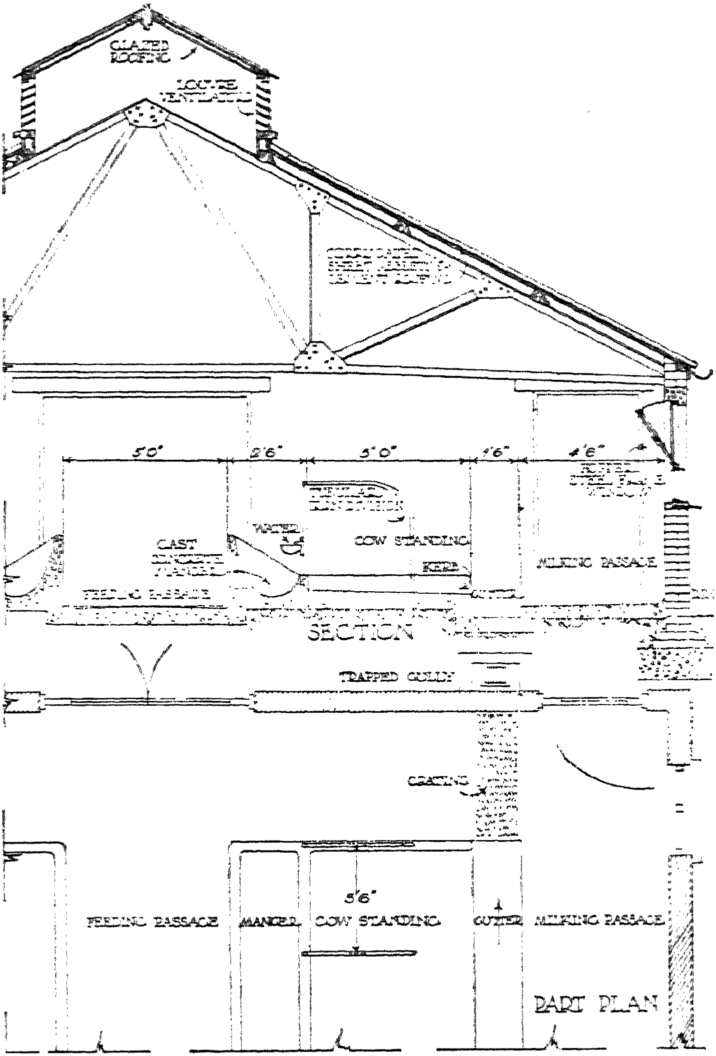

FIG. 6. Double Range Cow-house with Central Feeding Passage.

feeding passage 4 feet wide at the animals' heads and a milking and dunging passage 4 feet 6 inches wide at their rear. For a larger number of cows a double-range house is desirable. Here the cows may either face one another across a central feeding passage at least 5 feet wide, or stand tail to tail, the one row separated from the other by a central milking and dunging passage at least 6 feet wide. Each cow should have 800 cubic feet of space, any height over 16 feet to be neglected in the calculation. The standings should vary, according to the size of the cow, from 5 feet to 5 feet 6 inches deep from front to back, and, if double, 6 feet 3 inches to 7 feet 6 inches wide. The floor should have a fall of $1\frac{1}{2}$ to 2 inches to the manure channel, which should be at least 4 inches deep and 18 inches wide, and should drain to a trapped gully outside the cow-house. The floor material should be cement concrete, finished with a slightly roughened surface. The feeding trough may be made of cement concrete and may extend the whole length of the standings. Each animal should have its own drinking-water basin. Divisions between standings as well as the yokes are best made of galvanised steel tubing. A cow should be fastened so that it does not have to lie down in its own excrement. Internal walls should be rendered with cement, angles should be rounded off where possible, and lime-washing of the walls and ceiling should be done twice a year (see p. 606). Lighting and ventilation must be good. Three square feet of lighting area should be allowed for each animal. Hopper windows in the walls may be used, but many prefer top lighting. Apart from the windows, there should be at least 40 square inches of fresh-air inlet area per cow. Inlets are placed usually about 5 feet 6 inches or 6 feet above the floor. A ridge ventilator in the roof forms the best outlet for foul air. ("The Construction of Cow-houses," Miscellaneous Publications, No. 40, Ministry of Agriculture and Fisheries, 1924.)

2. The cow-house should be washed out just before milking and the udders and flanks of the cows should be washed and dried. Nothing should be done just before milking to create any dust. The animals should be kept well groomed.

3. Milkers must be healthy. Clean caps and overalls should be worn. Hands should be washed and dried prior to each milking. A hooded pail or one with a side aperture should be used, and all pails should be sterilised and kept covered when not in use. Milking stools should be well scrubbed. Special milking machines are frequently employed and give satisfactory service if dismantled and thoroughly cleansed and sterilised between milkings.

4. Ordinarily the milk is filtered immediately after being drawn. If all proper precautions are taken this should be unnecessary. In any case milk should be passed over a cooler,

which is usually a corrugated metal apparatus through which cold water runs, and over which the milk is allowed to flow in a thin stream. The cooler should have a cover and be placed in a position where contamination from dust, etc., is unlikely. Bacteria will not multiply to any extent in milk kept below 50° F.

5. After being cooled the milk should be filled into clean, narrow-necked bottles with press-on metal caps, and maintained below 50° F. till delivery. Special carton containers are now available, but are not used to any great extent.

Milk is now frequently transported by rail and road in large tanks—the special railroad tank having a capacity of 3,000 gallons. The tanks are glass-lined and surrounded with an insulating layer of cork 2 inches thick. It is claimed that the increase in the temperature of the milk during transit is not more than 1 degree. After being washed and scrubbed the tanks should be sterilised by steam at a pressure of 30 lb. to the square inch. It is obvious that if milk from one farm containing tubercle bacilli is mixed with non-infected milk from many other farms in one of these large tanks the risk of infecting human beings will probably be minimised owing to the dilution. On the other hand, this bulking of milk makes it extremely difficult to trace back infection to any particular farm when a sample of tank milk is found to contain tubercle bacilli. Sampling of bulked milk has now been discontinued (see p. 357). ("Milk Supply coming into London—Infection with Tubercle Bacilli," Report of Central Public Health Committee, L.C.C., 26 October, 1933.)

Clean milk production is stimulated all over the country by the holding of clean milk competitions and by other forms of educational work by county councils. That milk can be produced in a thoroughly clean manner and at little extra cost to the farmer can be seen by reference to an article by Anderson and Meanwell in the *Medical Officer*, 1 April, 1933, p. 125. In the experiment there quoted excellent results were achieved by ordinary farmers in a small way of business who attended to the following points—cleansing of udders, clean dry hands in the case of milkers, discarding the first jet of fore-milk, and sterilisation by steaming of all utensils in a simple wooden box fitted over the farm copper. Ample powers for enforcing clean production of milk are given to local authorities in the Milk and Dairies Regulations, 1926 to 1943 (see p. 605).

It is unwise to place too much reliance on bacteriological standards for milk. In the M.R.C. Report No. 206, 1935, Wilson pointed out some of the difficulties, particularly in relation to the plate count, and recommended the use of a methylene-blue reduction test for the routine grading of raw milk. This recommendation was adopted in the Milk (Special

Designations) Order, 1936, and a bacteriological plate count is now officially required only in the examination of pasteurised milk.

The Milk (Special Designations) Regulations, 1936 to 1943, were made by the Minister of Health, after consultation with the Minister of Agriculture and Fisheries. Power to make such regulations is given in the Food and Drugs Act, 1938, Sect. 21. See p. 612.

It is no easy matter to free a herd from tuberculosis. Not only must all positive reactors to the tuberculin test be eliminated, but all infected stalls, etc., must be carefully disinfected. In this connection, scorching with a painter's blow-lamp is a useful measure. Infected manure must be kept away from pasture as it has been shown that tubercle bacilli survive in pasture land for several months. Water supplies must be carefully protected. Pigs and poultry should be kept apart from dairy cattle, and stock bulls must be subjected to the same treatment as other members of the herd. Under the Attested Herds Scheme an attempt is being made gradually to establish areas in various parts of the country where the herds will be free from tuberculosis. This plan has met with success in Canada and the U.S.A.

Tuberculosis (Attested Herds) Scheme, 1938. This scheme was made by the Minister of Agriculture and Fisheries. It is intended to encourage the establishment of herds officially certified as free from tuberculosis. Herds so certified are known as attested herds and are registered by the Ministry of Agriculture and Fisheries.

All animals in the herd must have passed an official tuberculin test made by a veterinary inspector of the Ministry. Such a test is made only if the management of the herd and the conditions in which it is kept are considered satisfactory, and if the herd has passed two tuberculin tests (" qualifying tests"), carried out on behalf of the owner, without reactors being found. If not more than 10 per cent. of reactors have been discovered at one of these early qualifying tests and the owner has disposed of the reactors and disinfected the premises in the approved manner, the Minister will make a contribution towards the cost of additional qualifying tests. Once the herd has passed the final official test and a certificate of attestation is given, a bonus is payable in respect of the animals in the herd. Re-testing must be carried out annually. A bonus is also paid in respect of the milk produced by an attested herd. Swine kept on the same premises as the attested herd may be required to be tested at the owner's expense. The movement of cattle on to the premises of an attested herd is prohibited without a written permit from the Ministry. Fencing on the farm premises must be properly maintained. No animals

in the herd may be vaccinated against tuberculosis. "No milk or dairy by-product shall be brought on to the premises of an attested herd for feeding to animals except direct from the premises of another attested herd unless such milk or dairy by-product has been converted into powder form or is boiled or pasteurised."

The following procedures must be carried out after the removal of reactors from a herd :—

(1) After reactors have been taken out of that part of the premises to be disinfected and before removing manure, fittings or other materials therein, the premises must be freely sprinkled or saturated with an approved disinfectant ;

(2) manure must then be removed and stacked remote from cattle and pigs, and must not subsequently be scattered on pasture land ;

(3) after the removal of the manure all parts of the premises with which the cattle or their excretions and saliva have come in contact must be thoroughly scraped, the scrapings removed and the premises then scrubbed and washed thoroughly with a 4 per cent. solution of washing soda in hot water and finally sprayed with an approved disinfectant :

(4) all utensils, or other articles, used for and about the cattle must be thoroughly cleansed and washed with a 4 per cent. solution of washing soda in hot water. The boots and hands of persons carrying out the disinfection must be washed in an approved disinfectant ;

"Approved disinfectant" means a 5 per cent. solution of standard phenol or a disinfectant otherwise approved by the Ministry for the purposes of the Diseases of Animals (Disinfection) Order, 1936.

On 31st March, 1939, there were 4,633 attested herds in England and Wales.

The slaughter of "open" or advanced cases of tuberculosis in cattle is essential, and is provided for in the Tuberculosis Order, 1938 (p. 616). The operation of this Order (which was first issued in 1914) has probably done little, however, to lower the incidence of tuberculous infection in milk. "Open" cases are usually infective for some time prior to their detection and the policy of paying compensation, as laid down in the Order, for animals suffering from advanced disease is of questionable value. During 1942 the number of cattle reported in Great Britain for compulsory slaughter was 13,480, of which 3,719 were slaughtered as affected with tuberculosis of the udder. In addition, 75 cows slaughtered showed no clinical evidence of disease in the udder but were shown by biological test to be giving tuberculous milk. Fifty-six per cent. of the animals slaughtered suffered from advanced tuberculosis and the total compensation paid amounted to £93,193. In accordance

with the provisions of the Agriculture Act, 1937, the Ministry of Agriculture and Fisheries has arranged for the routine examination of all dairy herds by their veterinary inspectors. It is hoped ultimately to inspect four times a year herds which are replenished by purchase of cattle in the open market, and self-contained herds twice a year. Such inspection has been in operation in Scotland for some time, and there is no doubt that it is of material assistance in obtaining cleaner methods of milk production. The early diagnosis of tuberculosis, however, is not easy on clinical grounds alone, and routine inspection is probably of most service in the detection of tuberculosis of the udder. If, from information received from the M.O.H., a divisional veterinary inspector has reason to believe that tubercle bacilli are present in the milk from a herd in his area, he should arrange for a veterinary inspection of the cattle in the dairy and proceed as if he had received notice of suspected disease under the Tuberculosis Order.

The prophylactic vaccination of calves against tuberculosis has also been advocated, and experimental work has been done with B.C.G. and with the Spahlinger vaccine (Ministry of Agriculture, Government of Northern Ireland, " Report on Spahlinger Experiments, 1935 "), but the procedure is regarded as being still in the experimental stage. B.C.G. given to uninfected calves shortly after birth, preferably by the parenteral route, does increase resistance to tuberculosis. It must be remembered, however, that the vaccination renders the animals allergic, so that the tuberculin test can no longer be used to indicate the presence of infection with virulent bacilli.

The Food and Drugs Act, 1938, Section 25, prohibits the sale of tuberculous milk, or milk from cows suffering from tuberculosis (see p. 586). Under the P.H. (Prevention of Tuberculosis) Regulations, 1925, no person who is aware that he is suffering from tuberculosis of the respiratory tract may engage in any process involving the handling of milk or milk vessels, and, if any such person is actually so engaged and is in an infectious state, he may be required by the local authority to discontinue his occupation—compensation may have to be paid him. The Milk and Dairies Regulations give a M.O.H. power to exclude persons suffering from infectious disease, or contacts, from any process involving the handling of milk, and also to stop a supply of milk for periods of twenty-four hours if he is satisfied that any person is suffering from infectious disease conveyed by such milk (see p. 606). Under the P.H. (Infectious Diseases) Regulations, 1927, any person suffering from typhoid fever, paratyphoid or dysentery, or a carrier of any of these infections, may be excluded from any

occupation connected with the preparation or handling of food and drink (see p. 554).

Safe milk. Raw milk, as already indicated, may carry various infections and even milk from tuberculin tested herds may contain organisms pathogenic to man.

The only way of ensuring a safe milk supply is to require that all milk sold to the public should be submitted to an efficient pasteurisation process as laid down in the Milk (Special Designations) Regulations, 1936 to 1942. In Toronto not a single case of infectious disease has been traced to milk since compulsory pasteurisation was introduced in 1915. It is worthy of note that one of the rules of the Ministry of Agriculture and Fisheries required to be observed in relation to the Attested Herds Scheme, states that "No milk or dairy by-product shall be brought on to the premises of an attested herd for feeding to animals except direct from the premises of another attested herd unless such milk or dairy by-product is pasteurised or sterilised by heat." If such precautions are necessary in the rearing of calves, they should surely be regarded as equally necessary in the case of human infants.

Pasteurisation. The methods adopted in this country are (1) "Holder process"—milk retained at a temperature of not less than 145° F. and not more than 150° F. for at least half an hour and immediately cooled to a temperature of not more than 55° F, and (2) "High Temperature Short Time" process—milk retained at a temperature of not less than 162° F. for at least fifteen seconds and immediately cooled to a temperature of not more than 55° F. In both these methods of pasteurisation little change takes place in the milk. The fat emulsion may be slightly affected so that cream may rise less readily, and about 5 per cent. of the lactalbumin is rendered insoluble. The proportion of insoluble calcium is increased by about 6 per cent. and the iodine is reduced by about 20 per cent.

"Holder" Pasteurisers. In the vat process the milk is heated, held and, if necessary, cooled in one receptacle. The vat must have a proper cover and agitator for the milk, it must be jacketed so that the jacket may be heated by hot water or steam and, if necessary, cooled by cold water. This type is made in sizes of 50–200 gallons capacity and is suitable for the small trader.

In large dairies there is usually a separate heater and tanks which hold the milk at the proper temperature for the requisite time. Heating is best done by hot water and the milk must not at any time come in contact with the air. In inspecting a pasteurising plant the following defects should be looked for—faulty valves, foaming in the holding tanks (the foam may be 8°–12° F. below the temperature of the milk), dead ends in pipes and inadequate arrangements for temperature and time

control. (Ministry of Health Report No. 77, 1935, "The Supervision of Milk Pasteurising Plants.")

"*High Temperature Short Time*" *Process*. Here the process is the same in principle as that employed in the holder process except that the holding tanks are dispensed with and the flow of milk is regulated by a valve which is thermostatically controlled, allowing the milk to pass only after it has been subjected to a temperature of 162° F. for fifteen seconds. The advantages claimed for the high temperature short time process are that there is no waste of time and the milk may be bottled within a few minutes of entering the plant. The plant occupies less floor space than a machine of the holding type of similar capacity. ("High-Temperature Short-Time Pasteurisation and its Practical Application to the Dairy Industry," *J. Milk. Tech.*, May–June, 1941, Vol. 4, pp. 128–37, Hileman, J. L., and Leber, H.).

Stassanisation is a modification of the above process and takes place in a completely closed pipe in which the milk is distributed in thin layers. The temperature reached is 165° F. and contact with the heating surface is from fifteen to sixteen seconds.

Electricity has been advocated as the source of heat in certain high temperature short time processes, one of the best known of which is the "Electropure."

There is ample evidence (fully reviewed by G. S. Wilson in "The Pasteurization of Milk," Edward Arnold & Co., 1942) that there is no significant difference in nutritive value between raw and pasteurised milk.

Pasteurisation of milk efficiently performed as required in the Regulations may be relied on as an effective method of destroying tubercular and other pathogenic organisms. It will also destroy the huge bulk of other organisms, but a milk which has a high bacterial count in the raw state will not pasteurise so well as a clean milk. Pasteurisation will not make satisfactory a milk which was unsatisfactory in the first instance. Thermophilic organisms, growing at the temperature employed in pasteurisation, may be found in raw milk and may be present in large numbers after pasteurisation. They are most likely to be found in pasteurisation plants which are run for long periods (five or six hours or more) without being dismantled and sterilised, and it is thought that their presence may be due originally to lack of sterilisation of the equipment used in the production of the milk—milking machines, pails, strainers, coolers and the like.

In this country and the U.S.A. the great bulk of the milk supply of large cities is pasteurised and delivered in bottles. In the U.S.A. 88 per cent. of the milk supplied to cities with a population of over 10,000 is pasteurised and 98 per cent. in cities over 500,000. In London over 90 per cent. of the milk

is pasteurised and in Manchester and Glasgow between 80 and 90 per cent. Up to the present the control of pasteurisation has been left largely in the hands of big distributing companies. It is to be hoped that in future local authorities will encourage their officers to study the process and to exercise close supervision over the pasteurising plants in their areas.

A simple colorimetric test has been devised for estimating the efficiency of pasteurisation. The test depends on the fact that the enzyme phosphatase is destroyed by "legal" pasteurisation temperatures, but not completely destroyed if milk is heated at a lower temperature or for a shorter period than those laid down in the Milk (Special Designations) Regulations, 1936 to 1942. Milk containing as little as 0·25 per cent. of raw milk in the properly pasteurised bulk still contains detectable quantities of the enzyme. The test is of far greater value when positive than when negative. Samples kept at room temperature should preferably be examined within eighteen hours of having been heat-treated, but may be kept longer in a cold store at 32° to 40° F. If so kept, they should be raised to room temperature before being tested. Samples which show a taint or clot on boiling should not be tested. The reliability of the results of this test depends upon the strict observance of the instructions contained in Min. of Health Memo. 139/Foods, 1937, and the Addendum, 1943. (*Lancet*, 4th September, 1937, p. 595, Hoy and Neave.)

"The Pasteurization of Milk," Wilson, G. S. (Edward Arnold & Co., 1942), should be consulted by all interested in this important subject.

Bottle washing. Efficiently pasteurised milk may be spoilt by dirty bottles. It is possible in modern washing machines to attain something approaching sterility in the cleansed bottles. The process includes both soaking and rinsing with clean water and with water containing caustic soda to which trisodium phosphate or sodium metasilicate may be added with advantage. In most large bottle-washing machines the re-circulated rinse water tends to become heavily contaminated with bacteria. Bottles should be stored inverted in a clean, well-ventilated room. Single-service waxed cardboard containers are excellent but expensive. The best alternative is a narrow-necked bottle with press-over aluminium cap covering the rim. (*J. of Hygiene*, April, 1943, pp. 96–120, "The Cleaning and Sterilization of Milk Bottles," Hobbs, B. C., and Wilson, G. S.).

Preservation of milk

Boiling, if prolonged, completely sterilises. Milk just raised to the boiling-point is not sterilised. A large amount of sterilised milk is sold in this country. Such milk is usually

first homogenised and then heated in bottles either in a water bath or by steam under pressure.

Dried milk. Two methods of manufacture are employed—

(*a*) Milk is sprayed on the surfaces of two metal cylinders placed side by side at a distance of not more than 2 mm. The cylinders are heated by steam to a temperature of about 140° C. and rotate in opposite directions. The milk collects in the gap between the cylinders and is carried round in a dry film on the surface till it comes in contact with two knife-edges which scrape off the pellicle. The flakes of dried milk are then pounded and packed in tins.

(*b*) The milk is strained and then warmed and separated if so desired. It is next pasteurised at a temperature of from 70° to 75° C. and concentrated in a vacuum pan at 58° C. to less than half its original bulk. When sufficiently concentrated it is heated to 95° C. and immediately cooled to 58° C. again. From the pan it passes to a pump which forces it, under a pressure of from 2000 to 3000 lbs., as a fine spray into a tin-lined chamber to which a current of hot air at 115° C. is also admitted. The milk droplets are dried at once and fall on the floor. The dried milk is collected, sifted and packed. On account of oxidation this latter method is probably more destructive to the vitamin content than the former where the temperature is higher.

If packed in air-tight tins, dried milk keeps very well. It is portable and does not suffer in transit. As a result it is used largely on board ship and in the tropics. There is little waste, as only what is required at the moment need be made up. About half the lactalbumin is rendered insoluble as well as the salts of calcium, and the ferments are destroyed (Lane-Claypon). The anti-scorbutic vitamin is damaged by the process of drying. Hence, when dried milk is used for infant feeding, an anti-scorbutic, such as orange juice, should be given. Bacteria are not all killed in the process, but their numbers are reduced. Probably many organisms are introduced during the stages of powdering and packing. Tubercle bacilli may survive and be capable of infecting guinea-pigs, but their virulence is much diminished. Dried milk represents a concentration seven or eight times that of the milk from which it was prepared.

The following figures show the average composition—

Fat	25–28	per cent.
Protein	25–28	,,
Sugar	34–40	,,
Ash	6–7	,,
Water	5–7	,,

Little adulteration is practised, but cane sugar, bicarbonate of soda, phosphates, boric acid, and salicylic acid have been known to be added. No preservative is allowed.

Condensed milk. Three varieties are common—

(*a*) Whole milk unsweetened.
(*b*) Whole milk sweetened.
(*c*) Skimmed milk sweetened.

Typical percentage figures for the three varieties are—

	Total Solids.	Fat.	Lactose.	Proteins.	Cane Sugar
(*a*) . .	38	12·4	16	8·3	—
(*b*) . .	77·2	13·7	15	9·7	37·2
(*c*) . .	67·6	0·3	16·6	12·3	35·8

The concentration is roughly three times. Condensed unsweetened skimmed milk is also manufactured but is much less popular than the other varieties.

Process of manufacture. Fresh milk, after being strained, is pasteurised at 80°–85° C. Cane sugar, 14–15 per cent., is added, and the mixture run into copper vacuum pans. These pans hold from 1000 to 3000 gallons and are heated by means of steam pipes at the bottom. The tops are connected with an exhaust. Milk is thus boiled under reduced pressure at a temperature of about 50° C. for from two to three hours. When the milk mixture has reached the proper consistency it is drawn off into metal cylindrical coolers, which rotate slowly in tanks of cold water for another two to three hours. The condensed milk is finally filled into tins which are clean but not sterilised.

Such milk is not really sterile. Staphylococci, streptococci, *B. subtilis* and various aerobic and anaerobic organisms have been found. From 130 to 2000, or more, organisms may be grown on agar from 1 gram of the milk. *Bact. coli* is usually absent, however, and no pathogenic organisms have been detected. Tubercle bacilli, added artificially, were destroyed in the process. Condensed milk usually keeps well, but tins not infrequently "blow," due to the presence of a yeast. In the tropics, sweetened condensed milk occasionally assumes a thicker consistency and develops a brown colour. The thickening is thought to be due to colloidal changes in the concentrated milk and does not appear to be proportional to the bacterial content. Preservatives are rarely found, and none is permitted by the P.H. (Preservatives, etc., in Food) Regulations, 1925.

Butter

Average analysis—

Fat . .	83·5 per cent.
Casein . .	1·0 ,,
Ash . .	1·5 ,,
Lactose .	1·0 ,,
Water . .	13·0 ,,

A limit of 16 per cent. of moisture is fixed by the Food and Drugs Act, 1938.

Salt is usually added in amounts varying from 0·5 to 6 per cent. It is said to prevent decomposition of the casein.

Process of manufacture. Either milk or separated cream is churned and the fat globules made to coalesce into a solid mass. Churning should be continued at a comparatively low temperature for about thirty minutes. The butter is subsequently well washed and beaten to remove as much curd and butter-milk as possible; this aids keeping. Cream is usually allowed to stand for some hours before being churned to allow of bacterial growth. The organisms producing this " ripening " of the cream have been isolated in pure culture, and are now used frequently as " starters " in dairies where pasteurised cream is used for butter-making.

Butter fat is a mixture of the glycerides of various volatile fatty acids, especially butyric, palmitic and oleic. The percentage of soluble volatile fatty acids, of which butyric acid is the chief, makes butter fat quite distinct from the majority of other fats, animal or vegetable, and on their presence depends the chief test (Reichert-Wollny) for distinguishing butter from margarine.

The two commonest adulterations are the admixture of other fats and the presence of excessive amounts of moisture. Artificial colouring matter is sometimes added—principally annatto. It must not be forgotten that butter made from the milk of Jersey cows often has an almost artificial yellow colour. No preservative may be used in butter.

Butter made from fresh cream contains relatively more bacteria than does milk, as the bacteria tend to rise to the surface with the cream. Butter made from tuberculous milk has been proved on many occasions to contain tubercle bacilli. On this account many are in favour of pasteurising cream before churning. A temperature of 145°–150° F. for a period of half an hour will kill all pathogenic organisms and will not seriously interfere with the manufacture of the cream into butter. Cold storage does not destroy tubercle bacilli in butter.

Margarine is made from refined animal and vegetable fats with the addition of milk to give a flavour of butter. Beef and mutton fat are sometimes used, but of late years vegetable oils, such as coconut, cotton-seed and sesame, have been more and more employed. Such oils contain only a trace of soluble volatile fatty acids, and consist mainly of the glycerides of oleic, stearic and palmitic acids.

Margarine must not contain more than 16 per cent. of moisture or 10 per cent. of butter fat. For the various legal provisions regarding margarine, see p. 588.

Margarine is a wholesome food and is now reinforced with 550 International Units of vitamin A and 60 I.U. of vitamin D per ounce.

Milk-blended butter in this country is usually imported butter into which an additional amount of milk has been worked. The Food and Drugs Act lays down a limit of 24 per cent. of moisture. It is a sort of substitute for margarine, but is not used nowadays to any extent.

Cheese is made from whole milk, whole milk and cream, or skimmed milk. The caseinogen is coagulated by rennet, and the mass pressed. Some months usually elapse before the cheese ripens naturally.

Typical analyses are :—

	Percentage.			
	Water.	Ash.	Fat.	Protein.
Cheddar . .	30·3–39·4	2·0–4·3	23·2–41·6	23·3–32·4
Cheshire . .	30·0–39·0	3·6–4·5	26·0–33·0	24·0–36·0
Stilton . . .	20·0–35·0	2·7–4·0	31·0–44·0	24·0–36·0
Cream . . .	23·0–31·0	0·3–1·2	60·0–75·0	3·0– 8·0
American . .	29·8–38·1	2·7–4·6	27·2–44·3	21·5–30·1
Dutch . . .	33·0–43·0	5·0–6·0	16·0–24·0	28·0–32·0

Most typical English cheeses are made from whole milk, but Stilton may be made from milk and cream. Cream cheese may contain as little as 6 per cent. or as much as 40 per cent. of fat. There are no legal standards. In Gorgonzola, moulds are added artificially, and a coating of barium sulphate is usually applied to the cheese. Roquefort is made from ewes' milk, and Dutch cheese from skimmed milk. Margarine-cheese is a mixture usually of skimmed milk and refined animal and vegetable fats. It must not be sold as "cheese."

Tubercle bacilli have been found in a considerable percentage of cottage cheeses examined. They may remain virulent for seventy days and, as many cheeses may be consumed within this period, the risk is apparent. As in the case of butter, this fact has been adduced as an argument in favour of making cheeses from pasteurised milk. Undulant fever has been caused by eating cheese made from goats' milk. A number of varieties of cheese made in the South of France, even ripened cheese such as Camembert, have fallen under suspicion. The organism dies out very rapidly as a result of lactic fermentation, so that there is little risk unless the cheese is made from untreated milk and consumed within a week.

Food poisoning is sometimes due to the consumption of cheese. Formerly the toxic agent was considered to be alkaloidal in character (tyrotoxicon), but the cause is most likely the undestroyed toxins of some specific organism, probably

of the Salmonella group. (Medical Research Council Special Report, No. 92, 1925.)

Whey is the watery part of milk separated from the curd. It contains all the lactalbumin, nearly half the calcium, most of the other salts, nine-tenths of the vitamin B_1, three-quarters of the riboflavin (vitamin B_2) and a very large proportion of the lactose of the original milk. Spray-dried whey contains 12 per cent. of first-class protein. It has good keeping qualities and is useful in the diet of invalids and as a component of modified milk preparations for infants. Sometimes lactose-free whey powder is used.

Eggs weigh on an average 2 ozs., the yolk forming about 30 per cent. and the white 60 per cent. The yolk, which is mainly fat, contains lecithin and some nucleo-protein. The white consists of albumin and water.

Analysis—

Protein	12·55 per cent.
Fat .	12·11 ,,
Salts .	1·12 ,,
Water .	73·67 ,,

Eggs may be examined for freshness by "candling." The eggs are held between the observer and a bright light to detect the size of the air space and any changes within the egg. In a fresh egg the air space is not more than a quarter of an inch in depth, and increases in proportion to the staleness of the egg. The yolk in a fresh egg is represented by a faint shadow of equal intensity throughout. If a "blood spot" is present, it can be detected as a dark area within the shadow of the yolk. Fresh eggs will sink in water or a 10 per cent. salt solution.

Dried eggs now form an important article of diet and their importation into this country has greatly increased during the war.

Egg powders are really nothing more than baking powders coloured yellow with tumeric or a coal tar dye, though lead chromate has been found. Such preparations have not the food value of eggs but are aerating agents used to simulate the raising and colouring properties of eggs. The correct description is "Egg Substitute Powder" but in many cases the trade names suggest that the powders contain eggs.

The Food Substitutes (Control) Order, 1941, prohibits the manufacture of food substitutes except under and in accordance with the terms of a licence granted by the Ministry of Food. This is to prevent the sale of worthless articles and, in the case of any substitute, to control the name, claims made for it and the price.

Under the Agricultural Produce (Grading and Marking) (Eggs) Regulations, 1930, the special grade designations under

which eggs must be sold are prescribed as well as the minimum weights of the various grades.

MEAT

Inspection of live animals. *Signs of illness*: Hanging head, dull eyes, roughened coat, occasional shivers, loss of appetite, hot muzzle, nasal discharge, cough, rapid breathing, watery dung with blood or mucus, blown abdomen, œdema, etc. Rectal temperature is normally about 101·5° F. and pulse rate 40.

Special diseases. *Anthrax*. General sickness, blood in stools and urine, rapid pulse and high temperature. A more chronic form may be observed, with recovery in certain instances. The diagnosis is made by discovery of anthrax bacilli in blood taken from the ear (see p. 132).

Foot and mouth disease. Vesicles, ultimately breaking down into sores, about the udder, mouth and feet. Nasal discharge, stringy saliva, feverishness.

Tuberculosis. Cows are specially affected. Pigs suffer frequently, sheep and goats very rarely. The main signs are cough, rapid breathing, hard nodules in the udder, and emaciation. Diagnosis may be confirmed by a positive tuberculin reaction (see p. 357).

Pleuro-pneumonia. General illness with dyspnœa, tenderness on pressure over the ribs, and signs of pneumonia.

Other diseases are actinomycosis, garget or inflammation of the udder, dysentery, jaundice, cowpox, etc.

In addition, sheep may suffer from braxy, louping-ill, rot, scab, etc.

Slaughter of animals. The Slaughter of Animals Act, 1933, made compulsory the stunning of animals with a mechanically operated instrument prior to slaughter. Sheep may be brought within the requirements of this Act and goats excluded by special resolution of the local authority. Slaughtermen must be licensed by the local authority. Jewish and Mohammedan methods of slaughter are still permitted. Animals are usually stunned with a bullet or captive bolt, or electrically in the case of pigs, and are then bled by an incision through the large neck vessels (see p. 592).

Prior to the war, on account of the enormous numbers of private slaughter-houses (approximately 15,000 in England and Wales), it was difficult to carry out satisfactory inspection, although the Public Health (Meat) Regulations, 1924, by introducing the requirement of notice of intention to slaughter, made the problem somewhat easier (see p. 599). During the war the Ministry of Food purchases all cattle and sheep intended for human consumption and is responsible for the arrangements made for their slaughter and for inspection of

carcases. The principal objections to private slaughter-houses are :—

1. Unsuitability of construction and difficulty in cleansing.
2. Close proximity to dwellings.
3. Retention of animals in lairs close to houses, frequently with awkward means of access.
4. Nuisance from bad storage of offal, and, at times, discharge of offal and blood into sewers.
5. Lack of proper storage for meat.
6. Impossibility of adequate inspection.

The advantages of public slaughter-houses are so obvious that it is necessary only to enumerate the main points :—

1. Animals may be spared much suffering.
2. Nuisances are removed from the neighbourhood of dwelling-houses, meat can be systematically inspected and waste products dealt with on the spot.
3. Properly conducted premises can be made to pay their way.
4. The public prefer to buy meat that has been officially examined. Meat, if conveyed in proper hanging-carts, does not suffer in appearance.

Local authorities were given power in the Food and Drugs Act, 1938 (see p. 591) to provide public slaughter-houses and to eliminate private slaughter-houses, though suitable sites in populous districts are expensive. There were, prior to the war, some 115 public slaughter-houses in England and Wales. (*Medical Officer*, 28th January, 1933, " A Note on the Closure of Private Slaughter-houses in Coventry," Massey.)

Requirements of a good slaughter-house. *Site.* On the outskirts of the town, but not too far from retail shops. If possible a railway should adjoin. There should be a good water supply and means of disposal of sewage. The site should allow for the possibility of future extension.

Buildings necessary. Lairs, rooms or halls for slaughter of animals and hanging of carcases, cold storage, offal and hide store, condemned-meat room, destructor, manure dump, boiler-house, dressing-rooms and lavatories, and offices.

It is advisable to have a special place for the slaughter of diseased animals, and arrangements may be made for tripe cleaning, gut scraping, fat melting, etc.

(See p. 592 for the memorandum and bylaws regarding slaughter-houses.)

Meat inspection. Carcases should be inspected as soon after slaughter as possible. Under the Public Health (Meat) Regulations, 1924, no person is allowed to slaughter an animal for sale for human consumption unless he has given at least three hours' notice to the local authority. Every organ and the associated lymph glands should be examined by inspection and palpation, and if necessary by incision.

How to proceed :—

Head. Examine the jaw for actinomycosis (" lumpy jaw "), the mouth, etc., for foot and mouth disease, and the glands (submaxillary, retropharyngeal and parotid) for tuberculosis.

Tongue. Palpate for actinomycosis (" wooden tongue ").

Lungs. Palpate, and cut into, for tuberculosis, parasitic cysts, pneumonia, etc. Examine the bronchial and mediastinal glands.

Liver. Palpate and incise. Inspect for tuberculosis, abscesses, necrosis, flukes, etc. Examine hepatic glands.

Stomach. Examine especially the external coat and the gastric glands for evidence of tuberculosis.

Spleen. Palpate and incise for anthrax and tuberculosis.

Mesentery. Examine glands.

Udder. Palpate and incise for tuberculosis, etc. Examine the supra-mammary glands.

Carcase. Cows show evidence of an udder; bulls have specially heavy bones, coarse dark flesh, not much scrotal fat (or fat generally), and a large erector muscle and penis; oxen have more fat generally than bulls, and the scrotal fat (" cod ") is plentiful; their general development is slighter.

Note any emaciation, hæmorrhages, œdema, emphysema, jaundice, etc., and examine the parietal pleura and peritoneum carefully for tuberculosis, pleurisy, etc. The pleura and peritoneum should never be removed (" stripped "). Rigor mortis sets in about twelve hours after slaughter if the animal was healthy. The meat itself should be light red in colour, firm, not too moist to the touch, and marbled with fat. There should be no unpleasant odour. Drugs administered shortly before death may taint a whole carcase. Decomposition is detected by alterations in appearance, smell, and consistence. Putrefaction is indicated, especially in refrigerated meat or hams, if a skewer, plunged into the flesh in the neighbourhood of bone, has an unpleasant smell on withdrawal. Fat amounts to some 15 per cent., and bone to some 20 per cent.

Offal consists of the parts which are removed in dressing the carcase of an animal killed for food. The word is a trade term and includes the head and tail as well as the heart, lungs, liver, spleen, kidneys, pancreas and tongue.

"*Slink veal*" is the flesh of newly-born or still-born calves. It is pale, watery and gelatinous. Lungs are collapsed. It is unfit for human food.

Horseflesh is dark and coarse, with a rather sickly odour, soapy feel and yellow fat. The horse has eighteen pairs of ribs (ox, thirteen) and the bones generally are larger. Horseflesh contains more glycogen than ox flesh. If a few drops of a solution of iodine potassium iodide are added to a decoction of the flesh, the presence of glycogen is indicated by a violet

coloration. The horse's liver has three distinct lobes (in the ox the liver has three indistinct lobes) and no gall-bladder. The kidney is not lobulated. There is no bone in the inter-auricular septum of the horse's heart as there is in the ox's. The horse's tongue is rounded and the ox's pointed.

Unsound meat. Apart from decomposition, emaciation, immaturity, death from drowning, etc., carcases may be unfit for food on account of definite disease processes. The chief of these are:—

Tuberculosis (differentiate actinomycosis, caseous lymphadenitis, cysticercal and echinococcal cysts in organs, pyæmic abscesses in liver, lungs, kidney and spleen). The diagnosis of tuberculosis is confirmed generally by the characteristic naked-eye appearance of the adjacent lymphatic glands. Evidence of tuberculosis in the lymph gland of an organ is held to be evidence of the disease in the organ. The lungs and pleuræ are affected in from 30 to 40 per cent. of all cases of tuberculosis, the pleuræ and peritoneum in 15–20 per cent. The serous membranes should never be stripped. Such a practice is sufficient to condemn a carcase. Disease in the udder affects usually one quarter only, and as a rule no abscess formation follows. Care must be taken in cutting up tuberculous organs not to smear infected material over sound organs or flesh. A knife used for incising a tuberculous focus should at once be discarded. The same rule should apply to any cloths used for wiping such carcases. In addition to the glands of the various organs, the following glands should be incised—the lower cervical, pre-sternal, suprasternal, subdorsal, prescapular, supramammary (or superficial inguinal), iliac, sublumbar, precrural and popliteal. A good deal of practice is required before an inspector can cut down on these glands with any degree of accuracy.

In the **Memorandum on Meat Inspection** (Memo. $\frac{62}{\text{Foods}}$), issued by the Minister of Health in 1922, the following instructions are given as to action to be taken in the event of evidence of tuberculosis being found in bovines and swine:—

A. *Organs.*

An organ shall be seized when tuberculosis exists on its capsule, or in its substance, or in the associated lymph glands.

B. *Head.*

The head, including the tongue, shall be seized if any of the lymphatic glands of the head are affected.

C. *Carcase.*

1. The entire carcase and organs shall be seized when the following conditions are found:—

(*a*) Tuberculosis with emaciation.
(*b*) Generalised tuberculosis.

Note. In determining whether the disease is generalised, the judgment shall be based on the sum of the evidence of disease

throughout the entire carcase and organs. The following conditions shall be regarded as evidence of generalisation :—

(1) Miliary tuberculosis of both lungs.
(2) Where lesions are multiple, acute, and actively progressive.
(3) Where there is multiple and widespread infection of the carcase lymph glands.
(4) Where there are diffuse acute lesions of both serous membranes (pleura and peritoneum) and any of the carcase lymph glands are enlarged or contain visible tuberculous lesions.
(5) Where, in addition to the presence of tuberculous lesions in the respiratory or digestive tracts, there are also lesions present in the substance of any one of the following—spleen, kidney, udder (or uterus or ovary), testicle, brain, and spinal cord or their membranes.
(6) Congenital tuberculosis in calves.

2. All cases of tuberculosis not included in the immediately foregoing regulation shall be regarded and treated as localised lesions, and the parts containing the lesions and contiguous thereto shall be condemned.

3. If an organ or portion of a carcase becomes contaminated by tuberculous material, it shall be treated as if it were a case of localised tuberculosis.

Caseous lymphadenitis—sometimes called pseudo-tuberculosis—occurs mainly in sheep, but is also found occasionally in cattle, rabbits and chickens. It is commonest in imported sheep carcases, especially from the Argentine, but is not unknown in animals reared in this country. The glands most usually affected are the prescapular and the precrural, but lesions may also be found in the muscular and bony tissues. The causal organism, the Preisz-Nocard bacillus, enters the animal through an abrasion of the skin. It is commonly the practice of meat inspectors at ports to examine 5 per cent. of all imported carcases of sheep for evidence of this disease. Memo. 62a/Foods of the Ministry of Health, 1937, gives the following instructions for routine inspection of carcases of sheep and lambs :—

" The prescapular, superficial-inguinal or supra-mammary, precrural, iliac, lumbar and renal lymph glands must be exposed and examined by incision and the kidneys must be freed and examined, but not necessarily detached from the enclosing fatty tissue.

Viscera. The viscera must be condemned if they are infected in any degree or if the whole carcase is condemned. If the viscera are free from any lesions they must be passed unless the whole carcase is condemned.

Carcase (including the head). If on examination, as indicated above, more than one lesion is found, the whole carcase, including the head, and the viscera must be condemned. If one lesion only is found, the carcase must be cut into four sections: (1) pair of legs ; (2) shoulders ; (3) breasts, flanks,

scrag ends; (4) saddle carrying the associated lymphatic glands. These sections must be further examined, and if no other lesion is found, all the sections, except that in which the one lesion found at the first examination is situated, must be passed and the affected section condemned. If one or more additional lesions are found, whether in the same section as that in which the first was found or in another section or sections, the whole carcase, including the head, and the viscera must be condemned."

Actinomycosis affects either the jaws (" lumpy jaw "), where the condition may ultimately go on to suppuration, or the tongue, where ulcers or nodules (internal or external) may be produced. Occasionally the lungs show deposits, and rarely the condition may become generalised. In the majority of cases it is sufficient to condemn only the affected parts.

Anthrax. The spleen becomes much enlarged and very soft; the blood is dark. The whole carcase should be condemned.

Pyæmia. An acute condition, with recent abscess formation and general signs of cloudy swelling, etc., in organs; the whole carcase should be condemned. In old-standing cases with localised abscesses only the parts affected should be seized.

Septicæmia. This group includes acute diseases with symptoms referable to the intestines, uterus, udder, etc. Such conditions have produced serious outbreaks of food poisoning in human beings, and on no account should the meat be passed for human consumption.

The following conditions demand the condemnation of the entire carcase and organs :—Anæmia (if pronounced), extensive bruising, general decomposition, general dropsy, emaciation associated with disease, swine erysipelas, foot and mouth disease, immaturity and still-birth, jaundice, acute septic mammitis or metritis, uræmia, septic pericarditis, swine fever, multiple tumours in the muscles.

Parasites. (For life-histories, etc., see pp. 180–185.)

Beef " measles " (cysticercal or larval stage of *Tænia saginata*) may be recognised as small grey, transparent-looking cysts, ranging in size from a pin's head to a pea. The parts most frequently affected are the muscles of the head, neck, and shoulders, the heart, and occasionally also the various organs. *Pig " measles "* (*Cysticercus cellulosæ* of *Tænia solium*) show much the same picture, but are rather more transparent, and are not found so frequently in the heart muscle. The cysticerci in either case may show caseous or calcareous degeneration. In the latter case a gritty sensation is noted on cutting. The carcase should be condemned save in the case of very mild infection.

Trichinella spiralis. The encysted larval stage is found in the

muscles of the pig, especially the diaphragm, the muscles of the tongue and throat, and the intercostal and abdominal muscles. The cysts are invisible to the naked eye unless they are calcified, when they appear as tiny white specks scattered over the surface of the muscles, especially at the tendinous attachments. Samples of flesh may be taken from the muscles most frequently implicated, carefully pressed between two glass slides and examined microscopically. A little acetic acid may be added to dissolve any calcareous deposit around the cysts. Carcases affected with trichinæ should be condemned.

Sarcosporidia are greyish, oval, tubular bodies with rounded ends which may be found intracellularly in the muscle fibres. One form known as *Sarcocystis miescheriana* occurs in the muscles of pigs and when calcified can be seen by the naked eye. Another form infects sheep and goats. These parasites do not seem to be transmitted to man, but, if the sarcocysts are generalised and visible to the naked eye, the whole carcase and organs should be condemned.

Other parasites whose presence does not necessitate condemnation of the whole carcase are :—

Hydatid cysts, found most frequently in the liver and lungs of sheep, cattle and pigs, and more rarely in the kidneys, spleen, heart, peritoneum, etc. The cysts may undergo caseous degeneration, and the condition is apt to be mistaken for tuberculosis. *Cysticercus tenuicollis*, the larval stage of *Tænia marginata* of the dog, is found most frequently in sheep, especially in the mesentery. The invaginated head has a long, slender neck, hence the name. *Flukes* produce the condition known as " pipey " liver. The ducts show fibrous proliferation and stand out on the surface of the organ. On section of the liver the flukes may be pressed out of the affected ducts. Only the organs concerned need be condemned. *Strongylus rufescens* is found in the lungs of sheep. When the embryos accumulate in large numbers they may cause local areas of consolidation especially on the margins of the lungs and give rise to an appearance not unlike that of tuberculosis.

Onchocerciasis is a nodular condition found especially in the brisket, flank, and forequarter of Australian beef. Less commonly the knee region of the hindquarter and the muscles generally may be affected. The names of " worm kernels," " nodules " or " nests " are given to the condition by butchers. The parasites are round worms (male 1½ inches long, length of female unknown) belonging to the genus Onchocerca (subfamily of tne filariidæ), and require to be taken up by a biting insect and to undergo development therein before they can be transmitted to another warm-blooded animal. The life-history of this species is not known, but the intermediate host is probably a culicoides or simulium. The nodules are fibrous and

contain the adults, and, on section, show small loops of female worm like pieces of catgut. The fibrous nodules are caused by some toxic secretion of the enclosed adult worms. The embryos migrate from the nodules to the skin, where they may be found microscopically in large numbers. The parasites do not survive the death of the cattle, and man cannot be infected as a result of eating such meat. The condition is considered, however, to render the infected portion unfit for human consumption, but the nodules are usually excised before export.

(*J. Roy. San. Inst.*, 1938, Vol. 59, pp. 436–43, Grace, L. B. A.)

Sausages contain a mixture of minced meat and bread-crumbs or meal, the relative proportions varying greatly. Soya flour is now added to bring up the protein value to pre-war standard. They are usually well spiced. The only preservative allowed is sulphur dioxide in the proportion of 450 parts per million. Horse flesh has been used occasionally, and may be detected by the glycogen test (see p. 379). Only sound, well-cleaned intestines should be used as sausage skins.

Meat extracts are made by boiling meat under pressure and evaporating the resultant extract *in vacuo*. They contain very little protein, and consist mainly of extractives and salts. Occasionally a little meat fibre may be added in an endeavour to raise the protein value of the extract.

Meat juices are manufactured without heating and contain more protein than do extracts.

Fish

Such fish as salmon, herring, and turbot contain more than 5 per cent. of fat while cod, haddock and whiting contain less than 2 per cent. As an article of diet fish has a similar nutritional value to that of meat. The protein content, especially that of the roe and milt, is high. Both the flesh and the oil of fish are rich in vitamins A and D. Sea-water fish (fresh, frozen or canned) are a useful source of iodine and contain five to ten times as much calcium as beef or mutton.

Stale fish is flabby and soft, pits easily on pressure, the eyes are sunken, the gills discoloured, there is a disagreeable odour and the flesh separates readily from the skin and backbone. Fish that has been kept on ice for a long time may have no smell but will change very rapidly after removal. (*J. Roy. San. Inst.*, October, 1941, pp. 181–86, "Inspection of Fish," Pilkington, G.)

Dibothriocephalus latus is conveyed to man through eating infected fish; the disease is rare in this country. (See p. 182.)

Shell fish are liable to be kept in "layings" contaminated by sewage, etc., from adjacent towns and their storage in shops is frequently very unsatisfactory. Some persons show a definite

idiosyncrasy with regard to shell fish generally—urticaria and gastro-intestinal symptoms invariably following their consumption. The most common disease conveyed by shell fish is enteric fever, and various outbreaks have occurred, notably at Southampton and Winchester in this country in 1902, and in U.S.A. in 1924–25. Cholera, too, has been attributed to the consumption of infected shell fish. Oysters taken from unpolluted sea water contain no *Bact. coli* or *Cl. sporogenes* (indicators of sewage contamination), while oysters from doubtful sources contain large numbers. The proportion of such organisms appears to be relatively greater in the shell fish than in the sea water in which they live. Both *Bact. typhosum* and *V. choleræ* may survive for some days in sea water and experimentally infected oysters may carry the organisms for several weeks, especially at low temperatures. Purification of bivalves, if transferred to unpolluted beds, may be effected naturally in from 2 to 3 weeks, or it may be carried out artificially in specially prepared tanks. Such systems are in operation in Conway, Lytham and Brightlingsea.

With regard to mussels, "briefly," according to Dodgson, "the process consists of spreading the mussels on wooden grids in large concrete tanks ; hosing them thoroughly before, mid-way through, and at the end of the process ; exposing them for two successive periods of 24 hours to water sterilised by chlorine, but from which all trace of active chlorine has been removed by sodium hyposulphite and, finally, sterilising the shells by a bath of water containing three parts per million active chlorine. Oyster purification differs from mussel purification only in the following respects : Oysters will not function (that is to say, open and discharge their contents) at water temperatures which are easily tolerated by mussels, so that, in winter time, covered tanks are used and the chill is taken off the water. In the summer uncovered tanks, similar to those in use for mussels, are employed. Further, a storage tank is provided in which the oysters can be kept until required, the market for them being more spasmodic than for mussels. They may be stored, with daily changes of sterilised water, up to a maximum of seven days. Finally, a different hosing device has to be employed as the shape of the oysters prevents thorough scouring by the single jet used in the case of mussels." Shell fish so treated should not yield more than five lactose fermenting organisms per c.c. Another slightly different method of oyster purification is described in an article in the *Medical Officer*, [illegible] December, 1939, p. 227, Hughes, E. (Supplement No. 53, U.S.P.H.S. Reports, 6th November, 1925 ; Public Health (Shell Fish) Regulations, 1934, see p. 598 ; the *Lancet*, 25th July, 1936, p. [illegible], and *Public Health*, June, 1937, p. 279, " Shellfish and the Public Health," Dodgson.)

FOOD POISONING

Food may be injurious to human beings in various ways.

1. Certain articles are toxic in themselves—*e.g.* poisonous fungi eaten in mistake for mushrooms.

2. Chemical contamination—*e.g.* metals in tinning processes, arsenic from harmful colouring matters, preservatives improperly employed, zinc from galvanised iron cooking pans (*Public Health*, 1928, Vol. 41, pp. 276–79, Hebblethwaite, A. S.). Tin has been found in cheese wrapped in tinfoil, in all probability due to the action of free lactic acid. In the Annual Report of the Chief Medical Officer to the Ministry of Health for 1929 it is stated that in a number of soft English cheeses examined in the Ministry's laboratory amounts of tin were found ranging from 0·7 of a grain up to 4·3 grains per lb. The presence of tin in canned foods was the subject of a Report of the Local Government Board in 1908, when the view was expressed that amounts of approximately 2 grains per lb. were not only unnecessary but also possibly deleterious to health. Tin poisoning is not derived from the lining but from the solder used in sealing the tins. Outbreaks of cadmium poisoning have been caused by cadmium metallic coating on utensils used in the preparation and storage of food. (*J. Amer. Med. Assoc.*, July, 1941, pp. 86–9, Frant, S., and Kleeman, I.). Antimony poisoning has occurred when cheap enamel ware has been acted on by acid fruit juices (Memo. 171/Med. Ministry of Health, 1933). There is no clear evidence that aluminium in food is harmful and the small amounts that may be derived from aluminium cooking utensils are unlikely to have any appreciable effect on health (Ministry of Health Report No. 78, 1935). In future there will doubtless be an increase in the use of stainless steel which meets the most exacting requirements of hygiene.

A town dweller's total daily intake of lead is estimated at about 0·50 mgm. (0·22 mgm. in food, 0·20 mgm. in water, and 0·08 mgm. inhaled as dust). Of this amount, 0·05 mgm. is stored in the skeleton, while 0·05 mgm. is excreted in the urine and 0·40 mgm. in the fæces. It is considered that a total daily intake of 1 mgm., or possibly even less, must be viewed with suspicion. As regards permissible limits for lead in various articles of food, the important point is not whether the limits themselves are safe, but what their effect would be on the total intake. It is suggested that 0·75–0·80 mgm. is the maximum permissible limit for the daily intake of lead and that every endeavour should therefore be made to ensure that individual foods are so prepared as to eliminate lead as far as possible. Lead in excess of 2 parts per million has been found in samples of baking powder and self-raising flour, sardine paste, silds (in aluminium boxes), meat cubes, curry, ground cloves, gravy,

tea, turmeric, synthetic food colours, gelatine and whelks. (Min. of H. Report No. 88, 1938, "Lead in Food," Monier-Williams.)

3. Parasitic infections.

4. Bacteria and their products—much the most significant group.

The Salmonella group of organisms is the most important. Many strains have been isolated and serological methods for their identification are available. The principal strains are *Bact. typhimurium* (*aertrycke*), *Bact. enteritidis* (Gaertner), *Bact. thomson* and *Bact. newport*. These organisms multiply rapidly in foodstuffs and possess powerful endotoxins capable of resisting 100° C. Food poisoning may therefore be due to an infection with living bacteria or to the absorption of toxins which retain their poisonous properties after the bacteria themselves have been killed by cooking. Apart from the endotoxins of the Salmonella group, an enterotoxin produced by certain staphylococci is a common cause of food poisoning associated usually with milk or confectionery. It has been estimated that about one third of the outbreaks of food poisoning in Great Britain are due to staphylococcal intoxication, another third to toxic substances formed by other species of bacteria and the remaining third to infection by living Salmonella organisms or, in a very much smaller proportion of cases, by dysentery bacilli. Botulism—a condition produced by absorption of the toxins of *Cl. botulinum*—is referred to later.

The following table shows the vehicles of infection in 121 food poisoning outbreaks (Great Britain, 1919–31) associated with the presence of living Salmonella strains :—

Milk and milk products (milk 5, cream 1, ice-cream 3, junket 1 trifle 2)	12
Meat pies (pork 10, veal and ham 3, various 3)	16
Minced meat foods (minced or potted 8, brawn 6, sausages 3, stuffing 1, other 3)	21
Canned foods (beef 2, salmon 4, fruit 2)	8
Somewhat manipulated foods (salted beef 2, pressed beef 2, meat stews 2, ham 2, bacon 2)	10
Eggs (duck 6, egg sandwiches 1)	7
Fresh meat (pork 2, beef 1, mutton 2, veal 1, unspecified 2)	8
Various (fried fish 2, shellfish 2, other 1)	5
Not ascertained with reasonable certainty	34
	121

(*J. Preventive Med.*, Vol. 6, No. 6, November, 1932, p. 425, Savage.)

Ducks' eggs are the eggs most commonly implicated, infection entering the egg during its formation in the oviduct or even through the intact shell. It is important that food infected with Salmonella organisms has ordinarily a wholesome appearance. The most common vehicles of infection are meat and meat (especially pig) products, such as brawn, pies, sausages

OUTBREAKS OF FOOD POISONING (EXCLUDING BOTULISM), 1926–38.

Vehicle.	Great Britain.	U.S.A. and Canada.	Other foreign countries.	Total.
Meat or fish preparations . .	22	20	34	76
Milk and milk products... . .	5	11	16	32
Pastry or cakes, cream or custard filled	3	22	1	26
Eggs (mainly duck) . . .	3	0	15	18
Chemical poisoning (all non-tinned foods)	6	5	6	17
Tinned foods	2	2	2	6
Foods other than above . .	5	8	18	31
Total.	46	68	92	206

and the like. Such articles of food are often imperfectly cooked, are handled considerably and may be allowed to stand for some time after preparation.

The meat may be derived from an animal infected during its life with a specific organism or it may come from a healthy animal and be contaminated in course of preparation. Meat from "emergency slaughtered" animals has frequently been the cause of outbreaks. Milk may be infected either from an infected udder or from infected fæces. (Min. of Health Report, No. 82, 1938.) Infection of meat, which was originally sound, may be due to contamination by rats or mice or by human carriers. Not much is known of human carriers of Salmonella infection, but it is well established that both rats and mice suffer from infection with *Bact. typhi-murium* and *Bact. enteritidis*.

The type of food containing toxins of the Salmonella group is frequently canned meat or potted meat or fish products. Outbreaks of food poisoning due to staphylococcal toxin have usually been associated with milk products, especially pastry filled with cream or custard.

Outbreaks are most numerous in the warmer months. The infectivity rate is generally high, and often all those who have eaten the incriminated food fall ill. The symptoms are almost always those of gastro-intestinal irritation of varying severity, diarrhœa, vomiting and abdominal pain being practically constant. (*a*) When toxins are the cause, the symptoms commonly appear within two to four hours; they are acute in their onset and very severe. High temperature, prostration, and cramps suggest absorption of toxins. (*b*) When living Salmonella organisms as well as a considerable quantity of toxins are ingested, the incubation period is often twelve hours or even longer. The initial symptoms are less acute

and abrupt, more constitutional symptoms are present, and their duration is longer. (*c*) In some of the milder outbreaks the symptoms are purely those of gastro-intestinal irritation without the absorption of any toxic substances. The incubation period is short, recovery is rapid, and no after-effects follow. No case of the paratyphoid fever type has been encountered.

It is impossible to give the exact case mortality figure as the total number of sufferers is never discovered. It is, however, approximately from 1·1 to 1·8 per cent. In a series of sixteen outbreaks due to milk involving about 2,640 cases the case mortality was less than 0·2 per cent. In Aberdeen in 1919, however, an outbreak of gastro-enteritis, due to the infection of milk with a Flexner type of dysentery organism, caused over 1,000 cases with 72 deaths. (*J. of Hyg.*, 1926, Vol. 25, pp. 434–43, Kinloch, J. P., Smith, J., and Taylor, J. S.)

Botulism is the disease caused by *Cl. botulinum*, a sporing anaerobe found nearly always in food which will allow of anaerobic development. The primary site of *Cl. botulinum* is the soil. The earlier outbreaks of botulism were mostly associated with sausages, hams, and other meat foods packed under conditions excluding free air passage, while most of the recent outbreaks have been connected with preserved foods, especially vegetable foods, packed in tins, glass, or stoneware. The bacillus is proteolytic, and sets up decomposition changes in the food if it multiplies sufficiently to produce toxin. Hence in botulism the implicated food is usually, but not invariably, physically altered. In some American outbreaks, mostly connected with canned asparagus, beet, spinach, string beans (especially home canned) and olives, no physical change was detected, and in the Loch Maree outbreak (1922) the potted meat was not noticeably altered. As some days must elapse before sufficient toxin can be developed to cause poisoning, fresh food and recently prepared made-up dishes never give rise to botulism, however contaminated they may be with the spores. The toxins are destroyed by heating for half an hour at 80° C. The spores are more resistant—in the more acid foods, 100° C. for fifty minutes may be required; in the less acid, 100° C. for 180 minutes.

The onset of symptoms is usually from eighteen to thirty-six hours after ingestion of the food, but may be earlier or considerably delayed. In about one-third of the recorded cases symptoms of gastro-intestinal irritation have preceded the characteristic symptoms. At first diplopia and unsteadiness on standing occur, then palsy of the ocular muscles, inability to protrude the tongue, loss of speech, dysphagia and paralysis of the respiratory muscles. Consciousness remains to the end, and there is usually no fever, disturbance of sphincters, or headache.

In the Loch Maree outbreak in Scotland the case mortality was 100 per cent. Since then several other possible cases have been recorded in England. Antitoxic serum has not proved very efficacious in treatment.

BOTULISM OUTBREAKS, 1926–38.

Vehicle.	Great Britain.	U.S.A. and Canada.	Other foreign countries.	Total.
Meat or fish preparations, not tinned	2	1	5	8
Vegetable preparations . . .	2	1	0	3
Home-canned foods . . .	0	27	0	27
Commercial canned foods . .	0	2	0	2
Doubtful	0	0	1*	1
Total . . .	4	31	6	41

* Vehicle a mixture of blood, sausage and preserved beans (not stated if the beans were tinned or preserved otherwise).

(" Report of the Circumstances attending the Deaths of Eight Persons from Botulism at Loch Maree," Scottish Board of Health, Leighton, 1923; *B.M.J.*, 11 January, 1935, p. 64; *Lancet*, 4th November, 1939, pp. 991–95, " Canned Foods in relation to Health," Savage, W.).

Administrative measures include skilled meat inspection at the time of slaughter, separation of slaughter-houses from places where food is prepared, thorough cleanliness of premises and reporting of all cases to the M.O.H. Food poisoning is a notifiable condition under the Food and Drugs Act, 1938, Section 17, and under the same Act registration is compulsory in respect of all premises used for the sale or manufacture of ice cream, sausages and potted or preserved food.

The Ministry of Health Memorandum 188/Med., 1935, requests local authorities to inform the Ministry as soon as possible of any death or illness in which food poisoning is suspected, and offers the facilities of the Ministry's pathological laboratory for bacteriological examination of material. The Memo. includes the following suggestions :—

As soon as the M.O.H. has established the probability that a particular food, prepared in his district, is at fault, he should at once make detailed investigation into the conditions of its preparation and should obtain material for bacteriological or chemical examination. He will naturally take steps without delay to prevent further consumption of the suspected food by stopping its sale and recovering unconsumed portions already sold.

It will usually be advisable to secure samples from all

available food materials in addition to those suspected at first sight, since it sometimes happens that food not originally suspected ultimately proves to be the material at fault. This is of special importance when it is suspected that the illness is due to an inorganic poison.

To confirm the suspicion that a particular food is at fault, a full list of everything consumed at the suspected meal by all the persons present, together with the clinical history of each person attacked, should be obtained as early as possible. The determination of the circumstances in which food poisoning has occurred often turns upon apparently trivial points, accurate recollection of which may be impossible after some days' interval. For convenience of reference a list of headings of inquiry is appended to the Memorandum.

It is not necessary nor is it desirable to await the result of bacteriological or chemical examinations before commencing inquiries as to the manner in which the poisonous elements (bacterial or other) gained access to the food, as supplementary inquiries can always be made when the laboratory findings are known. For example, if there is any possibility that the food has been contaminated by arsenical or other poisonous substances during transport, inquiries should be made from the railway companies or other transport agencies concerned.

When the food suspected to have caused poisoning has not been prepared in the district, the M.O.H. should gain the co-operation of the vendor who should be invited to produce original packages and invoices, and any facts available to show by what manufacturer or distributor the implicated food was supplied to him, by what route, on what date and in what bulk. The Ministry would be glad to be informed at once of the facts obtained in any such cases.

Collection of material. (1) It is important to secure samples of any remaining portions of the *food actually consumed* by persons attacked; even minute fragments in discarded containers may be of value. Should this be impossible, food of similar origin or prepared from the same ingredients should be collected, though such specimens are much less likely to throw light on the cause. In the case of canned or potted foods the containers with labels intact should be preserved. A history of the consumption of ducks' eggs within a reasonable time before onset of illness would suggest attempts to trace the flock from which the eggs came, to obtain eggs from this flock and to examine the blood of the suspected ducks for evidence of recent Salmonella infection.

(2) Pathological material should be obtained from the sufferers in the acute stages of the illness whenever possible. Fæces or, failing these, rectal swabs are of the greatest importance; urine is less likely to give positive results in

bacterial food poisoning, but it is important when chemical investigation is indicated. Vomited matter is not often of value bacteriologically, but should be sent when available. From *fatal cases*, portions of the small and large intestines, spleen, liver and kidney should be obtained. The stomach (unopened and ligatured with its contents intact) is valuable if metallic poisoning is suspected, but is not of much use otherwise.

(3) Samples of blood for serological tests (at least 1 ml.) should not be collected until a week has elapsed from the onset of illness since the agglutinins to be investigated will not have fully developed till then.

Packing and transmission. Food specimens and all pathological material should be kept in an ice-box or refrigerator, if delay in dispatch is unavoidable. Specimens of excreta for bacteriological examination should be small in amount; in the case of fæces containing much mucus, a throat swab dipped in the mucus makes a satisfactory specimen; otherwise, clean, wide-mouthed, firmly corked or stoppered bottles make suitable receptacles. Food may be put in a clean tobacco or sweet tin. The organs from fatal cases should be wrapped in a clean cloth which has been wrung out of 30 per cent. glycerine solution. Contact with disinfectants must, of course, be avoided in the collection and transmission of all specimens.

It is usually difficult to provide cold storage during transport, It may be improvised by packing the specimens in their containers in a large biscuit tin containing crushed ice and itself packed in a wooden box with at least 2 inches of sawdust or absorbent cotton between. The specimens in their containers should be well wedged to prevent shifting as the ice melts. If ice cannot be easily procured, the specimens should be sent without it rather than be delayed.

The package should be marked "URGENT" and addressed to :—

Medical Department (Med. I),
Ministry of Health,
Whitehall,
London, S.W.1.,

and should be sent by post or by passenger train if more prompt delivery can be thus effected, notifying the Medical Department, as above, in advance if possible.

Chemical examination. When the circumstances point to poisoning not of bacterial origin, samples with all the information available should forthwith be sent for chemical analysis, ordinarily to the public analyst of the area. Although bacteriological examination of specimens is much the more important, chemical analysis is sometimes indicated, *e.g.* for the presence of preservatives, the determination of acidity, etc. Nothing is to be gained by sending specimens of meat foods to the analyst to

be examined for "ptomaines." It is doubtful if "ptomaines," in the sense of alkaloidal substances produced by bacterial action in meat foods, have any significance or connection with food poisoning. (M.R.C. Report No. 91, 1925; *Public Health*, January, 1936, p. 132, "Food Poisoning," Anderson, Phillips and Tighe; *B.M.J.*, 17th July, 1937, p. 106, "Food Poisoning—its Epidemiology and Bacteriology," Jones; *B.M.J.*, 14th November, 1942, p. 584, and 21st November, 1942, p. 615, Savage, W.)

VEGETABLE FOODS

Wheat and wheat flour. The skin of wheat has seven layers, all of which are present in commercial bran. They include the complex pericarp (outer epidermis or epicarp, mesocarp, cross layer and inner epidermis), the testa, nucellar and aleurone layers. These layers amount to 12 per cent. by weight of the whole grain; the endosperm (86 per cent.) and the embryo or germ make up the remainder.

In times of peace it has been the practice in many countries to mix cereals in the manufacture of flour, but in the British Isles it has been wholly milled from wheat at varying extractions up to 70–73 per cent. in the case of straight run flour. While there has been a limited demand for wholemeal flour richer in proteins than white flour, there is a marked predilection to the white loaf which has led to the bleaching of flour which in its natural state has a faint yellow tinge.

The earlier processes which had bleaching as their sole aim have, however, been largely superseded by improvement processes whose object is not only to enhance the colour and brightness of the loaf, but, what is of greater importance, to regularise the baking quality of the flour so that consistently good quality bread may be obtained. This is particularly important in this country since many different varieties of wheat of widely different baking quality are normally used. The whole question of refinement or the devitalisation of cereals is linked up with other sociological facts not confined to any one nation; thus in the Far East highly milled and polished rice is preferred with the removal of the pericarp and most of the aleurone layer. In the case of flour, those parts of the wheat berry which contain most vitamin B_1 are pigmented and when ground into the flour it becomes dark and specky. They also contain enzymes and other substances, which alter the baking characteristics of the flour so that it cannot be baked into bread with the same ease, nor will it produce bread of the same character. Lastly, the keeping property of white flour is superior to that of wholemeal, which spoils in storage more quickly especially if its moisture content is above 14 per cent. and the conditions are not satisfactory. Flours of 70 per cent.

or lower extraction are more digestible than those of higher extraction, and this is due to the bran or bran layers rich in indigestible fibrous material which the latter contain. It has, in fact, been shown that whereas a 70 per cent. extraction flour is 98 per cent. digestible, the corresponding wholemeal has a digestibility of only 85 per cent. The digestibility of intermediate extraction flours will depend upon the efficiency of the milling process, but the average present-day national flour has a digestibility of 94 per cent.

National flour is of 85 per cent. extraction and is milled chiefly from a mixture of Manitoba and English wheats. The percentages depend upon many factors, including the stock position of both wheats so that the percentage of English may vary from 30 to about 50. In addition the wheat grist contains 10 per cent. barley, or a mixture of barley and groats (dehulled oats), the latter not exceeding 3 per cent. The reason for this low limit with groats is that this cereal pulls down bread quality much more than barley. National flour also contains 7 oz. of creta præparata (calcium carbonate) and 2 lb. of skimmed milk powder per sack of 280 lb.

No cereal contains enough calcium to provide the growing animal with perfect bones and teeth, as it contains phytic acid which prevents the body making effective use of some of the calcium in the food by forming an insoluble calcium salt and thus preventing absorption. Some of the phytic acid is broken down during baking, but the phosphoric acid which is formed has the power of immobilising calcium in the intestine. All high extraction flour contains more phytic acid than white flour and, to meet the increased shortage of calcium thus produced, the prepared chalk has been added to the flour. In the national flour there has been a reduction of the fibre content due to new methods of milling which has improved the quality and the digestibility of the flour.

The vitamin B_1 and riboflavin contents of the flour are approximately 1·0 I.U. and 1·5μ *g/g* respectively as compared with a white patent flour (*i.e.*, the endosperm of wheat) for which the corresponding figures are 0·2 and 0·5.

The average B_1 value of wheat is 1·4 I.U. per gramme; 80 per cent. of this is located in the germ. The germ itself is not uniform and the scutellum fraction contains thirty to forty times the amount of B_1 that is present in the embryo which is about the same weight. Nutritionally therefore it is desirable for flour to retain the maximum amount of the scutellum.

Rye yields good if somewhat dark-coloured bread and biscuit flour. "Millable rye" may be mixed with wheat flour to make bread. Rye differs somewhat in composition from other cereals, but is only slightly lower in protein content than wheat, is about equal to wheat in carbohydrates and has a

similar starch equivalent. The following are comparative figures (per cent.) :—

	Digestible Protein.	Digestible Fat.	Digestible Carbohydrates.	Starch Equivalent.
Wheat . . .	10·2	1·2	63·5	71·6
Oats . . .	8·0	4·0	44·8	59·5
Barley . . .	7·6	1·2	60·9	71·4
Rye . . .	9·6	1·1	63·9	71·6

Bread. Gluten is the nitrogenous part of the flour of wheat and other grains. The properties of dough are due to the gluten it contains and during fermentation CO_2 is produced which causes it to expand and form minute cavities to which the porosity of the bread is due. Alcoholic fermentation which takes place in the dough depends on changes brought about by the action of enzymes present either in the flour, in substances added to the dough as improvers or in the yeast.

Bakers can now be furnished with standardised yeast of high vitamin content containing 66 I.U. per gramme which is further controlled by the use of " dough conditioners," so that a baker can make a well-piled loaf of bread uniformly of the texture, flavour and colour desired. Bread-making consists of three stages : preparation of the leaven or ferment, preparation of the " sponge," and the making of the dough. In the long process the dough is allowed to ferment for ten hours, while in the short process five hours or less is the limit. The temperature reached during baking rarely exceeds 100° C. in the centre of a 4-lb. loaf. The addition of creta præparata and skimmed milk to the national flour has had no effect on its baking qualities but, speaking generally, there has been a fall in the quality of the loaf, although, nutritionally, it has improved.

It is calculated that the average person eats five-sevenths of a pound of bread daily in which there is approximately 0·13 of a gramme of calcium, which is the amount contained in one-sixth of a pint of milk. A good loaf should be well risen and the crumb of good texture, evenly aerated and free from large cavities. The crust, in addition to being thin, crisp and unbroken, should have a bright brownish tint. The bread should be sufficiently moist and soft and should remain so for a reasonable length of time without showing signs of sourness or mustiness. The average composition of bread may be taken as water, 40 ; starch, 50 ; proteins, 8 ; fat, 0·5 ; and salts, 1·5. The crust usually contains about 16 per cent. moisture and the crumb 40–45 per cent. Working at optimum absorption one

280 lb. sack of flour will yield 380 lb. of bread; 1 lb. of flour will give approximately 1·36 lb. of bread.

Rope in bread fortunately is now rare, but when it occurs is a most damaging disease. It appears usually about twelve hours after baking as small brown spots in the crumb which gradually spread and make the whole crumb moist and slimy. Bread attacked by this disease develops a disagreeable smell and is totally unfit for food. The causal organism is commonly found in soil and often attacks potato crops, and the disease was more frequent when potato ferments were used. The *Bacillus mesentericus* is now said to be the causal organism which affects the ears of wheat and gets into the flour during milling, especially in the case of the low grade flours. ("Mineral Metabolism of Healthy Adults on White and Brown Bread Dietaries," *J. Physiology*, 2nd June, 1942, pp. 44–85, McCance, R. A., and Widdowson, E. M.).

Baking-powders (L.G.B. Food Report, No. 13, 1911) usually contain an acid salt and bicarbonate of soda with a starch diluent. In the presence of moisture CO_2 is evolved. The acid salt is either a tartaric acid one or acid calcium phosphate. Self-raising flour is simply flour to which a measured amount of baking-powder has been added. Acid calcium phosphate may contain large quantities of calcium sulphate as an impurity; 10 per cent. should be regarded as the allowable limit. "The addition of appreciable quantities of needless mineral matter, which contributes nothing to the value of the baking-powder, is to be deprecated." Furthermore, arsenic has been detected in acid calcium phosphate and tartaric acid preparations in amounts exceeding the accepted limit of $\frac{1}{100}$ grain per pound. Such impurity is due to the manufacture of sulphuric acid from pyrites.

Custard-powders. Real custard is made from eggs, milk, and sugar, but custard powders contain no eggs and are as a rule made of coloured and flavoured maize starch, but sago, potato or rice have been found. Their average analysis is 1 per cent. of protein and 0·3 per cent. of fat. They have not the food value of custard, and their substitution in the case of invalids, especially diabetics, may be serious, as the thickening in one is due to starch and in the other to albumen. As in the case of egg substitute powders, the labels and advertisements are often very misleading.

OTHER VEGETABLE FOODS

Rice is composed mainly of carbohydrate with a small amount of protein. Modern methods of milling remove all the outer husk and leave nothing but the original endosperm. The rice grains may be polished by talc (consisting mainly of silica and magnesia) or other similar substance. They may also be

treated with certain blue pigments to increase whiteness, and with vegetable oils to increase translucency. It has been shown that beri-beri in natives is often associated with the consumption of this polished rice, which has lost those portions of the grain containing anti-neuritic vitamin. (Economic Advisory Council Rept., "Nutrition in the Colonial Empire," Appendix 6, "Rice and its importance for Human Nutrition," 1939, Platt, B. S.)

Beans, peas, and lentils are of considerable nutritive value on account of the large amount of nitrogenous matter they contain. The protein exists mainly as legumin, and is not so digestible as meat protein. They are also deficient in fat as compared with meat. Lathyrism is a condition of gastro-intestinal disturbance, with at times paraplegic and other nervous symptoms, said to be due to the consumption of *Lathyrus sativus*, one of the vetches.

The soya bean, while successfully used as an addition to wheat and rye flour both in the United States of America and on the Continent, has not been used to any extent in this country. Soya bean flour contains 40 per cent. of protein of good quality, at least equal to that of whole wheat and superior to the proteins of white flour and to those present in peas and ordinary beans. It has a fat content of 20 per cent. and in consequence has a high calorific value—about 470 calories per 100 grammes, as compared with 370 for white flour. (*B.M.J.*, 23rd August, 1941, p. 269.)

Potatoes consist mainly of water and starch. They are important as an energy-bearing food and their calorie and carbohydrate content reckoned on a dry weight basis are equal to those of white or wholemeal bread. The protein (tuberin) is less in amount but possesses a biological value slightly superior to the proteins of whole wheat, in spite of the fact that the latter are more digestible and better absorbed. As regards minerals, the potassium is higher, the calcium lower, while the available phosphorus and iron are about equal in amount to that of white, though lower than that of wholemeal bread. Although not among the richest foods in vitamin C, and notwithstanding the losses caused in cooking, the large amounts consumed regularly make the potato a valuable antiscorbutic food in winter. In the raw state the vitamin C content is similar to that of the carrot but lower than that of the turnip. Losses during cooking in water are due to diffusion as well as to destruction of the vitamin and in this respect the advantages of steaming are evident. Slow methods of cooking or long periods of keeping hot as in "cooking boxes" may cause complete destruction of vitamin C and should be avoided. The vitamin B_1 (aneurin) content of the potato is greater than that of white bread and about equal to that of wholemeal bread when calculated as dry weights. Little is known of the

content of the other B vitamins. (*Medical Officer*, 7th December, 1940, p. 193, Chick, Harriette.)

Arrowroot is a prepared starch from the roots of the *marantaceæ*. It is obtained chiefly from the West Indies and South Africa. Many starches are sold as arrowroot which are derived from plants other than the *marantaceæ*, and the genuine article is liable to adulteration with cheaper starches. Tapioca is got from the root of the cassava plant, and sago from palm-pith ; both consist almost entirely of starch and water.

The Food Manufacturers' Federation, in conjunction with the Society of Public Analysts, has issued a memorandum of unofficial standards for jams. A minimum percentage of fruit varying from 30 lb. to 45 lb. per 100 lb. of jam must be present in first-quality jam and at least 20 per cent. of fruit in second-quality. Jams must be labelled " with other fruit juice " unless a mixed jam contains no added fruit juice or pectin. A complete examination of jam should include a search for arsenic and preservatives, and an estimation of the sugars present and possibly of the pectins, which determine the jellying properties of jam. (*Analyst*, 1930, 55, p. 694.)

BEVERAGES

Alcoholic. Ethyl alcohol is obtained from the fermentation of glucose, $C_6H_{12}O_6 = 2C_2H_6O + 2CO_2$. It has a specific gravity of 0·793, boils at 173° F., and freezes at − 203° F. " Proof spirit " is a mixture (57 per cent. by volume) of alcohol and water, and the strength of distilled spirits is usually expressed in this country in terms of proof spirit. A spirit is under or over proof according to whether it contains less or more alcohol than does this standard. The percentage of alcohol by volume multiplied by 1·75 gives the degrees or percentage of proof spirit.

Brandy should be made solely from fermented grape juice. Its colour is due to storage in casks and the addition of caramelised grape sugar. The aroma of brandy is due to various higher ethers, etc., and their presence serves to differentiate the real article from grain spirit, which is frequently used as a substitute. Whisky is made mostly from barley, both malted and raw. The colour is due to storage in sherry casks. Fusel oil or amylic alcohol is liable to be present in considerable quantity in new whisky. Rum is distilled from the fermented juice of the sugar-cane. Gin is made from grain and flavoured with juniper berries, etc. Both contain much the same amount of alcohol as whisky. Under the Food and Drugs Act, 1938, whisky, brandy, rum and gin must not be more than 35 degrees under proof (see p. 578).

Beer used to be made from malt or germinating barley with the addition of hops, but nowadays beers are made from any

PERCENTAGE OF PROOF SPIRIT AND OF ABSOLUTE ALCOHOL IN VARIOUS BEVERAGES

Name of Beverage.	Original Gravity.	Percentage of Proof Spirit.	Percentage of Absolute Alcohol by Volume.
GIN, WHISKY, BRANDY, RUM—			
At 25 u.p.	—	75·0	43·0
At 35 u.p.	—	65·0	37·0
WINES—			
Port	—	35·0	20·0
Sherry	—	35·0	20·0
Madeira	—	35·0	20·0
Burgundy	—	25·0	14·0
Tarragona	—	25·0	14·0
Champagne	—	18·0	10·0
Claret	—	18·0	10·0
Hock	—	18·0	10·0
Vermouth (1)	—	25·0	14·0
,, (2)	—	35·0	20·0
Empire Wines (1)	—	26·0	15·0
,, ,, (2)	—	38·0	22·0
British Wines	—	28·0	16·0
CIDER (bottled)	—	7·6	4·3
BEER (English)—			
Ale (1)	1070°	11·5	6·6
,, (2)	1055°	9·6	5·5
,, (3)	1045°	8·5	4·9
,, (4)	1040°	7·0	4·0
,, (5)	1030°	5·5	3·1
Stout (1)	1054°	9·3	5·3
,, (2)	1048°	6·8	3·9
Porter	1041°	7·0	4·0
BEER (Foreign)	1050°	8·5	4·9

AMOUNT OF PROOF SPIRIT AND OF ABSOLUTE ALCOHOL (BY VOLUME) IN IMPERIAL MEASURES OF VARIOUS BEVERAGES.

Name of Beverage.	Imperial Measure of Beverage.	Proof Spirit Fluid.	Absolute Alcohol.	
			Fluid Ounces.	Cubic centimetres.
Whisky (at 30° u.p.)	Two fluid ounces	1·4	0·8	23·0
Port	Four fluid ounces	1·4	0·8	23·0
Tarragona	Four fluid ounces	1·0	0·6	17·0
Champagne	Four fluid ounces	0·7	0·4	11·5
Claret	¼-pint (five fluid ounces).	0·9	0·5	15·0
British Wine	¼-pint (five fluid ounces).	1·4	0·8	23·0
Ale (original gravity 1040°).	One pint	1·4	0·8	23·0
	Half pint	0·7	0·4	11·5
Stout (original gravity 1054°).	One pint	1·9	1·1	30·0
	Half pint	0·9	0·5	15·0

The figures recorded in the Tables are average ones and variations from such figures are usual.

(*Alcohol—its Action on the Human Organism*, 1938, H.M. Stat. Office).

fermented saccharine infusion, and any wholesome bitter may be added. The wort is the unfermented saccharine infusion containing the hop bitters, and it is on the strength of this wort that excise duty is levied. The specific gravity of the wort is known as the "original gravity." Beer manufactured from glucose has been known at times to contain arsenic, the source of the arsenic being the sulphuric acid used for the inversion of starch to glucose. Stout owes its dark colour to roasted malt.

Wine is the fermented juice of the grape. Fermentation proceeds naturally without the addition of yeast. White wine is usually more acid than red. In the manufacture of red wine the skins of the black grapes are thrown into the fermentation vats with the result that the pigment is extracted. Brandy is often added to sweet wines to prevent further fermentation of the sugar. "Plastering" of wine means the addition of calcium sulphate. It aids keeping by removal of acidity and assists clarification. As a result of this process potassium sulphate tends to be formed, and, as an excess of this might be somewhat harmful, not more than 2 grammes of this salt per litre are allowed in France. Pasteurisation is frequently practised in France. It prolongs the life of a wine and is said to give an artificial flavour of age. Wine that develops "ropiness" may be renovated by this treatment. Acetous fermentation is apt to be set up in wine stored in casks, etc., that are not air-tight. This results in the formation of acetic acid from some of the alcohol. Much artificial wine is made from dried raisins. Artificial colouring matter, especially logwood, may be added to wines. The only preservative allowed in beer or wine is sulphur dioxide in amounts not exceeding 70 parts per million in the case of the former, and 450 parts in the case of the latter.

Cider and perry, on account of their acidity, may have a solvent action on lead, and have been known to cause symptoms of lead poisoning. (*Lancet*, 1st October, 1932, p. 717.)

Non-alcoholic beverages. Temperance wines may contain either sulphur dioxide or benzoic acid in amounts not exceeding 350 parts or 600 parts per million respectively.

Natural mineral waters, as a rule, are remarkably free from bacteria of any sort, but faulty methods of bottling may cause contamination. It is a wise precaution in cases of doubt to store the bottles for a fortnight before use, as pathogenic organisms are unlikely to survive for longer. The ordinary aerated-water siphon frequently shows gross bacterial contamination, and traces of such metals as copper or lead are occasionally found in the contents.

Tea. Black tea-leaves have undergone some slight fermentation before being baked; green tea is baked immediately after being picked.

Characteristics of the tea-leaf—notched apex, serrated margin, serrations tipped with spines, looped venation of primary veins. Under the microscope the under surface of the leaf shows well-marked stomata and unicellular hairs.

Theine (or caffeine), 1·5–5 per cent., is constantly present. These needle-shaped crystals are not found in exhausted tea—*i.e.* tea-leaves that have been previously used. As tea is examined carefully by the Customs officers, the old practices of adulteration with foreign leaves, facing of green tea with indigo or Prussian blue, etc., have practically disappeared.

Coffee—the seeds of the *Caffea arabica.* In the natural state two seeds are contained inside the fruit. These seeds are roasted before use in order to develop aroma, flavour and colour. A volatile oil, known as caffeol, is produced in the process, and to it most of the aroma and taste are due. Coffee contains just over 1 per cent. of caffeine (theine) and about 13 per cent. of oily matter. Chicory (prepared from the root of the wild endive) is frequently mixed with coffee.

The main points of difference are—

(*a*) Coffee floats on water and stains it but very little, whereas chicory sinks at once and colours the water brown.

(*b*) Coffee contains crystals of caffeine; chicory does not.

(*c*) Microscopically, coffee shows spindle-shaped cells with a dotted appearance; chicory shows spiral ducts with square-cut ends.

Cocoa is made by roasting and grinding the seeds (called cocoa beans) of *Theobroma cacao.* The seeds contain about 50 per cent. of fat and 1·3 per cent. of theobromine (similar to caffeine). The natural product is somewhat indigestible on account of its high fat or "cocoa-butter" content, so it is frequently mixed with starch and sugar. This is not a legal offence if the mixture is declared on the label. "Soluble Cocoa" has an alkali added to it, which emulsifies the fat and produces a more homogeneous mixture with water. Chocolate is a preparation of cocoa, sugar, starch and added cocoa fat, flavoured with vanillin and pressed into a cake.

Lime juice and *lemon juice* are expressed from the ripe fruits. They contain about 30 grains of citric acid per ounce. Brandy may be added as a preservative, or the juice may be pasteurised or boiled to aid keeping. Under the Merchant Shipping Act a daily ration of 1 oz. of such juice, in the absence of fresh vegetables, must be served out on ships ten days after leaving harbour. (See Statutory Rules and Orders, 1927, No. 36, Merchant Shipping—The Merchant Shipping (Anti-scorbutics) Order in Council, 1927.) Lemon juice was a valuable anti-scorbutic when first used as such many years ago, but in recent years it has been largely replaced by lime juice which contains less anti-scorbutic vitamin and loses a

portion of what it naturally possesses on account of modern methods of preparation. Orange juice is now taking the place of lemon juice as an anti-scorbutic for infants brought up on artificial foods. In the Royal Navy it is used as well as vitaminised lime juice crystals as an official issue, though more on account of providing a refreshing drink. In the Army for some years lime juice was replaced by germinating pulses but now both have been superseded by ascorbic acid tablets. Much fictitious juice is made from citric or tartaric acid with the appropriate flavourings. Lime juice cordial is simply lime juice sweetened with sugar. The only preservative allowed is sulphur dioxide or benzoic acid in amounts not exceeding 350 parts or 600 parts per million respectively.

Water. The body's greatest need is water and, while man can survive for weeks without food, if deprived of water he dies as a rule in a few days.

Under tropical conditions when doing hard work not only is the body deprived of water as sweat, but there is also a loss of sodium chloride up to as much as 24 grammes a day. In such a case, to maintain a balance, an intake of water up to 2 gallons a day may be required and the salt deficiency has to be made good. ("Dehydration," *Lancet*, 24th July, 1943, pp. 91–94, Morris, N.)

Vinegar. Malt vinegar may be made either from malted barley or from other cereals. The malt is mashed and soaked in successive quantities of hot water till all soluble material is extracted. To this extract yeast is added, and fermentation is allowed to proceed for three to four days. The fermented liquor is next pumped through an acetifier, where it is sprayed over basket work, etc., on which the *Mycoderma aceti* grows. In the presence of a sufficient supply of oxygen and a suitable temperature most of the alcohol is converted into acetic acid. Small amounts of other bodies, *e.g.* acetic ether and aldehydes, are formed which give malt vinegar its characteristic flavour. A little alcohol should be left, as it improves the flavour and acts as a preservative. The vinegar is subsequently clarified either by filtration or precipitation. Potassium ferrocyanide has been used for this purpose, but is not free from objection. Distilled vinegar is made by distilling malt vinegar. Wine vinegar is best made from white wine. Spirit vinegar is prepared by the acetous fermentation of dilute distilled alcohol, chiefly potato spirit. Vinegar should contain not less than 4 per cent. acetic acid, and no other acid, no lead or copper, and no colouring matter other than caramel should be present. There are, however, no legal standards. Artificial vinegar is made usually by diluting acetic acid (pyroligneous or wood acid). It is sometimes coloured with caramel. Sulphuric acid is at times used as an adulterant; action in such cases may be taken under the Food and Drugs

Act. No preservative may be added to vinegar. Occasionally pasteurisation is practised as a means of preservation. Metals such as lead, copper and arsenic may enter the vinegar during the process of manufacture. Added to tinned foods, vinegar tends to exercise a solvent action on metals.

PRESERVATION OF FOODSTUFFS

The following are the principal methods used in the preservation of foodstuffs :—

1. Exposure to low temperatures either just above or below freezing point.
2. Exposure to high temperatures with subsequent exclusion of air, exemplified in the process of canning.
3. Drying, either by exposure to the sun or by the use of artificial heat indoors often *in vacuo* (dehydration).
4. Smoking.
5. Air conditioning—alteration of the physical condition and chemical composition of the air.
6. Addition of chemical preservatives.

Exposure to low temperatures just above or below freezing point. The difference between freezing and chilling meat is one of degree, the former being subjected to a temperature below 20° F. and the latter to anything from 28° to 30° F. Chilled meat will keep for three weeks, but frozen meat will keep for three years without any noteworthy loss of nutritive value.

Cold storage consists of three stages : (1) freezing ; (2) storage in the frozen state ; and (3) thawing. Food may be frozen in air or in a cold solution. Low temperatures are usually produced by the rapid evaporation of ammonia, the resultant cold being communicated to brine, which circulates in pipes in the refrigerating chamber ; or air may be driven over similar pipes situated outside. If a solution is used, it is one containing salt or glycerine so that it will freeze articles in metal boxes placed in it, without itself congealing. With either method storage is carried out in an insulated chamber below freezing point. Meat stored in this way is sometimes attacked by moulds and certain yeasts. The most serious mould from an economic standpoint is the *Cladosporium herbarum*, which causes "black spot." These growths are harmless and may be removed. (*J. Roy. San. Inst.*, Vol. 47, 1926, pp. 336–340, Woods.) Frozen meat has a characteristic pink colour, and the fat is generally very white. Both frozen and chilled meat should be kept by butchers in refrigerating chambers, especially in warm weather. Perhaps the most important improvements in the chilled meat industry have been attained by attention to (*a*) ante-mortem factors, (*b*) hygiene in preparation and handling and the introduction of gas storage. The glycogen content of the muscles influences the *p*H value and this in turn

the rate of bacterial spoilage. An ample reserve of glycogen can be ensured by the resting and special feeding of animals before slaughter. Fish may be kept in ice for a week to twelve days on trawlers, and for the purpose of transit may be packed in boxes containing alternating layers of fish and ice. Fish frozen in brine at 5° F. and retained at that temperature will keep its appearance and nutritive value for three months. Eggs may be stored at a temperature not below their freezing point in a humid atmosphere to prevent loss of weight. These are known as "chilled" eggs. Eggs must be clean, fresh, and not have been exposed to a temperature of more than 60° F. "Frozen" eggs consist of "whole eggs"; "egg whites," (whites only); "sugared yolk", *i.e.* yolk plus 10 per cent. sugar; and "plain yolk" which have been frozen in tins at a temperature of 10·4° F. Eggs can be held at sub-zero temperatures for many years without deterioration. Common salt or sugar is sometimes added. Fruit does not readily lend itself to cold storage, and does not ripen during or after removal. In the case of vegetables an initial partial cooking or blanching is sometimes necessary to destroy the enzymes which may continue to cause changes at low temperatures. Milk, reconstituted cream, and butter may be preserved in the frozen state.

Exposure to high temperatures with subsequent exclusion of air. Canning. A meat-canning factory usually includes slaughter-houses, cooling rooms, kitchens, exhausting and retorting departments, can-making and lacquering departments and a laboratory. The most common types of can are the "hole and cap" and the "sanitary" patterns. In the "hole and cap" all the seams are soldered, an opening being left in the top for filling purposes. This opening is closed by means of a soldered cap when the can is filled. A small hole is left in the centre of the cap to allow air to escape during the exhaust process, after which it is closed. In the "sanitary" type of can no solder is used in the sealing process. Seams are made airtight by interposing a layer of rubber composition or a gasket of specially treated paper between adjoining margins of the top and bottom and body of the can, and the joint is made secure by means of a machine known as a "double seamer."

Soundness and suitability of raw material are essential, and all carcases are examined after slaughter. After boning and trimming the subsequent treatment varies according to the type of canned meat required. Par-boiling is necessary to produce shrinkage before canning, and generally takes fifteen to sixty minutes. The cans are filled either by hand or by machine, and then weighed and capped. They next pass into the exhaust chamber, and finally the small vent hole is soldered, or the lid of the "sanitary" can closed. Processing

or cooking is carried out at temperatures between 220° F. and 240° F. Rotating retorts which agitate the contents of the cans are now often used. These facilitate heat penetration which reduces the time of cooking. Among recent advances in food canning is " high short " processing in which high temperatures are applied for short periods. According to the heat penetrability of the food treated the periods may range from a few seconds upwards. The shorter the time the better is the quality of the final product. The cans are then sprayed with cold water; this causes them to collapse and become slightly concave at the ends. They are then lacquered and labelled. Samples of the finished article are sent for examination to the laboratory, where they are maintained at a temperature of 98° F. to 104° F. for fourteen days and the number of " blowers " noted. Sterility tests are also carried out.

The canned fish industry is becoming more important each year. The three principal classes of canned fish are :—

1. Boiled or steamed—salmon, mackerel, cod, herrings, lobsters, crabs and prawns.
2. Preserved in oil—sardines, brisling, tunny and anchovies.
3. Prepared with tomatoes—herrings, pilchards and mackerel.

Of all canned fish salmon takes the most prominent place. There are five varieties, of which sockeye, or red salmon, is the best. Most canners use automatic fillers for their cans.

The preservation of fruit and vegetables by canning also forms a very large part of the industry. The procedure is similar to that already described. Fruit juices can be flash-pasteurised at lower temperatures than most foods as the bacteria they contain are feebly heat-resistant.

The following are some of the principal faults found in filled cans :—

1. A leaky can is one in which air has gained admittance after the can was supposed to be hermetically sealed. If the leak be large, rapid changes may occur.
2. Blown cans are those in which putrefactive or fermentative change has taken place.
3. Short-process cans have not been sufficiently sterilised in the retort.
4. Collapsed cans are those in which too great a vacuum has been obtained—often the result of faulty filling.
5. Overfilled cans are strained by the forcing in of too large a quantity of meat.

(*J. Roy. San. Inst.*, December, 1927, pp. 276–282, Grant; pp. 283–289, Mackenzie.)

Canned food is examined at all ports of entry in the United Kingdom, and the wharfingers usually examine 10 per cent. for trade purposes. If the number rejected is small, the whole consignment is passed by the food inspectors. The methods of

examination are generally those of inspection, palpation, percussion, and shaking. *Inspection* reveals holes, indentations and signs of gross ill-usage; extensive rust is regarded with suspicion as it may cause perforation. The crimped or double-seamed joint between cover and body in sanitary cans should always be carefully inspected. "Swelling" or "blowing" is the most important defect noted by inspection. Here the ends of the tin are bulged, due to the formation of gas. Certain fruits act on the metal of the containers, producing electrolytic action with the formation of hydrogen ("hydrogen swell"), but, as such a condition is indistinguishable from blowing due to decomposition, the tins should be condemned. *Palpation* enables the inspector to detect the slightly blown can. If there is internal pressure from gas formation a sense of resistance will be felt as well. *Percussion* is very largely relied upon by inspectors. A sound tin emits a dull note, an unsound one usually a tympanitic note. Percussion is of little value in the case of canned marine products or fruits. *Shaking* should produce no sound in a tin containing canned meat, unless the meat is in a state of advanced decomposition and is partly liquid. Shaking is relied upon mostly in the case of canned marine products. (Annual Report, M.O.H., Port of London, 1936, pp. 46–52.)

About 1·5 per cent. of canned meat, and much less in the case of marine products, is rejected in this country. This figure does not include unsound tins detected by the packing firms and not allowed to leave the factories. In special instances X-ray examination may be used to obtain information regarding the condition of the container and of its contents. (*J. Roy. San. Inst.*, May, 1935, pp. 600–610, Walton.)

No class of canned food is always sterile. Savage found the percentage of non-sterile but sound samples as follows: meat 63·6, fish 48·6, crustacea 84·2, fruit 22·4, unsweetened condensed milk 18·2, and sweetened condensed milk, 100. He found that the obligate anaerobes and the *B. proteus* types usually give the most obvious signs of unsoundness and cause offensive decomposition of the contents; that non-proteolytic but fermenting types of non-sporing aerobic bacilli and fermenting yeasts tend to cause blowing without much change in the contents; that sporing aerobes give rise to decomposition but not to blowing; and that micrococci and most thermophilic bacilli cause neither external changes in the tin nor unsoundness of the contents. Thermophilic bacilli are less likely to cause spoilage in food canned for the home market than in those exported to the tropics as the air temperature is seldom high enough to favour the vegetative development of thermophilic spores. Tins should be absolutely airtight, not only because outside bacteria may enter, but also because the admission

of air provides conditions suitable for the multiplication of bacteria already present. The smaller the initial bacterial contamination the less likely is decomposition to ensue.

Fifty-eight outbreaks of food poisoning due to the consumption of canned foods occurred in this country between 1919 and 1931. In most cases the food appeared perfectly sound, and poisoning was caused either by living bacilli of the Salmonella group or by their undestroyed toxins. Between 1899 and 1931 there were one hundred and ninety-three outbreaks of botulism in the United States and Canada caused by foods in sealed containers, which included string beans, corn, olives and spinach. Compared with the enormous quantity of canned food consumed in the States these figures indicate that the risk of food poisoning from this source is extremely small. (*J. Preventive Medicine*, Vol. 4, July, 1931, "The Protective Measures in the State of California against Botulism," Meyer.) Lead poisoning from solder used in tins is unlikely, though Portuguese sardines examined in the Port of London have been found to contain up to 78 parts of lead per million. It is possible, though not probable, that poisoning from tin may occur, particularly in the case of old canned foods of acid reaction. Even the best tin-plate may develop defects, as the folding of the plate to make the seams breaks the tin coating. The iron-plate thus exposed is readily attacked by salts and other products, even by water and air alone if these are present. Sardines, herrings, and similar fish canned in oil or tomato sauce are particularly prone to attack the surface of tin plate, with the result that as much as 7 or 8 grains of tin to the pound have been found in some samples, an amount which is greatly in excess of the suggested standard of 2 grains.

Canning processes tend to affect adversely the vitamin content of the food, but if air is excluded during the heating process the loss of vitamins is greatly reduced. All cooking processes cause loss of vitamins which is increased by storage, but modern methods of canning are better controlled than domestic cooking and the loss in the case of the former may well be less.

The following are the keeping periods of certain foods, canned under the most modern methods: Sweetened full-cream condensed milk, six to nine months; unsweetened condensed milk, three years; canned fish, meat packs (sausage meat, meat rolls, gallantines) and soup, five years; vegetables in lacquered cans, two years.

Annealed glass containers are sometimes used instead of tins, and the sterilisation process is carried out in much the same way with the exception that lower temperatures are employed with a longer exposure on account of the liability of glass to

crack. An airtight seal between the glass vessel and the metal lid is obtained by the use of a rubber washer, the lid being held in position by means of a partial vacuum. The greatest cleanliness should be maintained in the preparation of food marketed in this manner. It is the practice of certain manufacturers to repack in glass containers meats which have been imported in tins. Glass particles are not infrequently found in food packed in glass containers. They are generally very minute in size and not a source of danger, though larger particles might cause injury with serious consequences. (A Report on the Occurrence of Glass Fragments in Food packed in Glass Containers, Ministry of Health Report No. 37, 1927.)

Special Reports Nos. 3 (1920), 10 (1922), 16 and 20 (1923), of the Food Investigation Board ; *Veterinary Record*, 4 November, 1933, pp. 1112–1126, "Meat Preservation," Wooldridge ; *J. of State Medicine*, Vol. XLIV., No. 9, 1936, "The Inspection of Canned Foods," White ; *Lancet*, 4th November, 1940, pp. 991–95, "Canned Foods in relation to Health," Savage, W.)

Drying (Dehydration). This method depends on the removal of the moisture necessary for bacterial growth. The process may be carried out by artificial heat or in the sun, The limit of useful drying is about 6 per cent. of moisture and before the food is consumed it is usual to replace the water. Modern methods have done much to preserve the vitamin content. Fruit, vegetables, meat, eggs, milk, can be preserved in this way.

In preserving vegetables it is necessary to retain the colour as well as the maximal nutritive properties which should also be present during storage. Cabbage can now be dehydrated and contains 70–80 per cent. of its original vitamin C, and, if cooked in the proper way, it will still retain 35 per cent. It is first rapidly scalded and this destroys the enzyme, after which it is dried in a current of air at a temperature never above 80° C. Dried vegetables prepared under modern conditions are said to keep well in storage. They are easier to cook and tests have shown that meals prepared from them provide as much vitamin C as those prepared from fresh vegetables, mainly owing to the difference in the losses during cooking.

In the manufacture of dried eggs, the water is removed by evaporation in the presence of heat. While there are many methods, some form of spray-drying is the commonest. The average analysis of the dried whole egg product is moisture 5·5, fat 41·5, protein 48·5, acid of ether extract 1·5–2. Dried eggs are normally free from moulds, yeasts and pathogenic bacteria. In the conversion of dried eggs back to liquid, it takes about 10 eggs to make 1 lb. of liquid.

Smoking. Smoking is a common method used for the treatment of fish and bacon. Here preservation is due not only

to drying, but also to a large number of compounds present in smoke from burning wood. The principal of these is creosote, which penetrates the tissues to a limited extent, killing bacteria and even spores, but as an albuminous layer forms on the surface penetration soon ceases.

Beechwood chips are usually employed in the case of ham and bacon. In the smoking of fish, as the process is rather to add flavour than to preserve, a careful choice of wood dust is made, that of oak, deal and hickory being most used.

Air conditioning. For many years certain foodstuffs have been preserved by the exclusion of air, *e.g.* coating with paraffin, butter or fat in the case of potted meats, etc., or the immersion of eggs in a solution of silicate of soda. Recent experimental work has shown that the conditioning of the atmosphere by the careful regulation of the carbon dioxide and oxygen content and of the humidity and air movement may be utilised to improve the keeping properties of certain perishable articles. Serious loss from brown heart of apples in transit from Australia called for investigation, and it was found that if ventilation was arranged so as to keep the carbon dioxide and oxygen content, as well as the temperature, at a certain level, the gas storage of apples was a practical proposition. The application of this principle to other fruits which cannot be kept in cold storage has been tried with undoubted success. In the case of tomatoes a temperature of 12° C. with an atmosphere containing 5 per cent. of oxygen and 5 per cent. of carbon dioxide gave the best results, and it was found that, as in the case of apples, a higher percentage of carbon dioxide was injurious. In contrast to these gases which delay the ripening of fruit, ethylene stimulates it. Bananas arrive in this country in a green condition and are ripened in special rooms in a concentration of 1 in 10,000 ethylene. Gas storage has now been extended to meat, and it has been found that an atmosphere of carbon dioxide, while it does not actually kill moulds and bacteria, slows down their growth and multiplication. Too much carbon dioxide produces a chemical change in the hæmoglobin which spoils the "bloom." The concentration of carbon dioxide must not exceed 20 per cent., and beef can be kept in first-class condition in 10 per cent. of gas at 32° F. for sixty to seventy days. This requires welded steel chambers in ships carrying meat. The gas is supplied from cylinders of liquid carbon dioxide and distant reading instruments give the concentration of gas in the chamber. Bacon can be stored in an atmosphere of 100 per cent. carbon dioxide at 32° F. for several months and at lower temperatures for even longer. Here the main problem is to prevent oxidation of the fat. Ozone is used in certain American and German abattoirs in a concentration of 1 to 2 parts per million. Ozone,

however, is a powerful oxidiser and fats particularly are apt to develop an unpleasant linseed oil taste if given an overdose. (*J. Roy. San. Inst.*, October, 1935, pp. 214–218, Moran, T.)

The gas storage of eggs in an atmosphere of nitrogen and carbon dioxide has met with success, the eggs showing no change when withdrawn after varying periods.

(*J. Roy. San. Inst.*, March, 1939, pp. 593–599, Tomkins, R. G. ; Annual Repts., Food Investigation Board, 1937, 1938.)

Chemical preservatives include boron compounds (usually a mixture of boric acid and borax), formaldehyde, sulphur dioxide, salicylic acid, benzoic acid and fluorine compounds. Such substances were used extensively in the past for the preservation of foodstuffs, but their use has been forbidden, with certain exceptions, by the **Public Health (Preservatives, etc., in Food) Regulations, 1925 to 1940,** which apply to imported food as well as to food produced in England and Wales. The exceptions are sulphur dioxide and benzoic acid in specified amounts in specified foods, and sodium or potassium nitrite in bacon, ham or cooked pickled meat. The Regulations prohibit the manufacture for sale or the sale for human consumption of any cooked pickled meat (except bacon and ham) which contains sodium or potassium nitrite in proportions exceeding 200 parts per million calculated as sodium nitrite. The term "preservatives" does not include salt, saltpetre, sugar, vinegar, glycerine, acetic acid, alcohol and spices, and the minute quantities of preservative agents introduced in the process of smoking. In certain instances the presence of a preservative must be declared. Various colouring matters are prohibited in food, and any thickening substance, save cane or beet sugar, is prohibited in cream. Any officer of the Ministry and any officer of the local authority acting in the execution of these regulations has right of entry at all reasonable times to any premises where articles to which these regulations apply are prepared, packed, labelled or stored. He may also take any necessary samples and must pay for such samples if required so to do.

For the schedules to the Regulations see p. 602.

Food adulteration. There is very little gross adulteration or deliberate substitution of one article of food for another nowadays and, while in 1875 some 20 per cent. of articles sent to the public analysts were found to be adulterated, the rate was only 5·7 per cent. in 1938. The cruder forms of adulteration have, however, given place to scientific treatment or "sophistication" of food by skilled chemists. Every sort of artifice is used to improve the appearance, colour, taste, and keeping qualities of the food, which may not be without definite risk to health or may impair its nutritive value. As instances one may mention : (*a*) the fumigation of food with toxic gases to destroy

insect pests, (*b*) the presence of heavy metals in foods due to the materials or containers used in manufacture and storage, (*c*) the increasing use of poisonous insecticides and fungicides in agriculture and horticulture, (*d*) the treatment of flour with

RESULTS OF ANALYSIS OF CERTAIN ARTICLES UNDER THE FOOD AND DRUGS (ADULTERATION) ACT, 1928, DURING THE YEAR 1938, AND COMPARISON OF THE PERCENTAGE ADULTERATED WITH THAT IN THE YEAR 1937.

	Number of samples.		Percentage adulterated.	
	Examined.	Found adulterated or not up to standard.	1938.	1937.
Bread	281	4	1·4	0·7
Butter	7,289	104	1·4	1·3
Cheese	1,760	79	4·5	4·7
Cocoa	930	4	0·4	0·3
Coffee (excluding mixtures)	1,275	10	0·8	0·6
Confectionery	1,304	22	1·7	2·9
Cream	1,622	27	1·7	1·7
Dripping	697	12	1·7	2·1
Flour	547	4	0·7	1·0
,, self-raising	726	7	1·0	1·5
Jam and marmalade	2,007	165	8·2	9·3
Lard	2,778	22	0·8	1·2
Margarine	2,662	39	1·5	1·3
Meat and meat products	5,402	306	5·7	6·2
Milk*	80,025	6,141	7·7	7·0
,, condensed	1,347	36	2·7	1·5
Suet	650	35	5·4	5·8
Sugar	1,139	43	3·8	1·9
Tea	1,603	10	0·6	0·6
Vinegar	1,648	152	9·2	12·0
Wine	418	11	2·6	2·5
Beer	597	66	11·1	5·5
Spirits	1,637	104	6·4	4·7
Drugs	5,973	303	5·1	5·1
Other articles	24,756	727	2·9	2·7
All articles	149,073	8,433	5·7	5·3

* Excluding "appeal to cow" samples.

(Annual Report of the Ministry of Health, 1938–39, Appendix X., p. 244.)

bleaching and "improving" agents, (*e*) "fortification" of foods by artificially added vitamins, (*f*) the uncontrolled and unregulated exposure of food to ultra-violet rays, or (*g*) the introduction of new synthetic colours and flavours.

Of late years ethylene glycol and its derivatives have been used for flavouring essences and ethylene oxide has been

employed as a fumigant for various foodstuffs such as grain, dried fruit, etc., which may become infested with maggots and weevils. There have been several cases reported of acute toxic nephritis due to the absorption of di-ethylene dioxide, which is closely related to ethylene oxide and ethylene glycol. Much more information on the physiological side is required before we can say whether ethylene glycol and its derivatives are harmless to man or that the fumigation of food with ethylene oxide or with methyl bromide is devoid of any risk to health.

A Departmental Committee on the Composition and Description of Food reported in 1934, and recommended that the Minister of Health should be empowered to make orders prescribing definitions or standards, or requiring declarations of composition, for articles (but not all articles) of food. This recommendation has been embodied in part in the Food and Drugs Act, 1938.

Much useful information on food problems is given in "Practical Public Health Problems," Savage (Churchill, Ltd., 1941).

SECTION VI

ATMOSPHERIC POLLUTION, VENTILATION, HEATING AND LIGHTING

Atmospheric pollution

THE composition of the external air is approximately, by volume :—

Nitrogen . . .	79·04 per cent.
Oxygen . . .	20·93 per cent.
Carbon dioxide. .	0·03–0·04 per cent.

The nitrogen figure includes nearly 1 per cent. of argon and traces of hydrogen, ammonia, neon, krypton, etc. Aqueous vapour averaging about 1 per cent. is also present. The amount of oxygen varies but slightly under normal conditions. The air of mines, however, sometimes contains as little as 18 per cent. Combustion is not supported with a percentage lower than about 17. An individual at rest feels no ill-effects till the oxygen is reduced to 11 or 12 per cent., and consciousness is retained till the figure reaches 7 per cent. The CO_2 content varies considerably, as much as 0·3 or 0·4 per cent. being not infrequently present in the air of ill-ventilated rooms. It is only when the amount reaches 3 per cent. that discomfort may be experienced by human beings. Nitrogen is an inert gas and need not be considered.

Products of respiration

The air of an occupied room may be affected considerably by products of respiration. Each respiration of an adult amounts to about 500 c.c. and the expired air has lost about 4 per cent. of oxygen, has gained about 4 per cent. of carbon dioxide, has been raised in temperature to nearly 37° C., and is almost saturated with moisture. Micro-organisms are also expelled from the air passages on forced expiration. Pure country air contains comparatively few organisms per cubic metre, but overcrowded rooms and workplaces may contain many thousands, more particularly if dry dust on the floor has been disturbed. During ordinary conversation organisms may be sprayed to a distance of 4 feet from the speaker, while coughing projects them at least 10 feet. In addition the human body gives off a great deal of moisture in the process of sweating, and

the heat evolved by an adult at rest is about 400 British Thermal Units per hour.

Products of combustion

Most atmospheric pollution in large towns is due to the products of combustion. The ordinary domestic fireplace is a great offender, while in the large manufacturing centres in the North and Midlands factory furnaces are responsible for the bulk of contamination.

Coal gas is made by the distillation of coal in vertical retorts. The products of distillation are passed through condensers where the liquid and gaseous portions are separated, through washers and scrubbers to remove ammonia, and through purifiers to free the gas from sulphuretted hydrogen, carbon bisulphide, and carbon dioxide. The final product is frequently mixed with a certain amount of "water gas" made from coke or "carburetted water gas" made from coke and oil.

The average composition of town's gas is :—

	Percentage by volume
Carbon dioxide	2·5
Oxygen	0·8
Various hydrocarbons	3·5
Carbon monoxide	15·0
Hydrogen	48·0
Methane	22·0
Nitrogen	8·2
	100·0

Sulphur, mainly in the form of carbon bisulphide, is also present in amount varying from 10 to 30 grains per 100 cubic feet of gas. The calorific value of such gas is 500, *i.e.* the number of British Thermal Units (B.Th.U.) per cubic foot.

One cubic foot requires 4·3 cubic feet of air for its complete combustion, and about 0·5 cubic foot of CO_2 and 1 cubic foot of water vapour are produced. Small quantities of sulphur oxides and nitrogen oxides are also formed. Escapes of coal gas are dangerous on account of the presence of large amounts of carbon monoxide.

Nuisance from smoke. It has been estimated that the volume of industrial smoke produced annually in this country is twice that of domestic. The latter is more objectionable, however, on account of the tarry matter it contains due to incomplete combustion. The sulphur content of coal varies from less than 1 per cent. to 3 or 4 per cent., and a quarter of this is discharged during combustion as SO_2. Large power stations may cause great nuisance on this account.

Atmospheric pollution may be measured by the standard gauge designed by the Advisory Committee on Atmospheric Pollution. It measures the impurities deposited and consists of a circular vessel composed of cast iron enamelled with a vitreous enamel. This rests on an iron stand raised 4 feet from the ground. The catchment area should be 4 square feet. An aperture in the bottom of the basin is connected to one or more large bottles placed underneath which receive the rain-water and everything else that falls into the gauge. Once a month the matter collected in the bottles is separated by filtration into soluble and insoluble matter, and may be further analysed into carbonaceous constituents, ash, tar, ammonia, sulphates and chlorides. The results are expressed in grammes per square dekametre (= metric tons per 100 square kilometres), or else in tons per square mile. Another piece of measuring apparatus is Owen's automatic filter which measures the suspended impurities. Here 2 litres of air are automatically drawn through thick white filter paper every quarter of an hour, and the stain left, when the air has passed through the paper, is a measure of the pollution of the air. A series of standardised stains has been prepared which enables an estimate of the pollution to be made. For the measurement of sulphur dioxide in the atmosphere, standard cylinders of 100 sq. cm. area coated with a preparation of lead peroxide are used.

A smoky atmosphere reduces the amount of ultra-violet light, increases fog, is probably productive of respiratory disease, and is damaging to buildings and vegetation. It has been estimated that the total cost to this country from the smoke nuisance is at least £80,000,000 a year.

The commonest causes of industrial smoke are :—

1. The use of fuels unsuited to the type of furnace.
2. The use of too much or too little draught in the furnace.
3. Draught not passing through or over the fire.
4. Careless and irregular firing.
5. Forcing of fire on account of insufficient boiler plant.

The remedies are the use of smokeless fuels, *e.g.* coke, especially in vertical furnaces; the provision of sensitive draught gauges and apparatus for estimating CO_2 in furnace gases ; frequent analyses of fuel; avoidance of scale inside boilers ; careful stoking, whether mechanical or by hand.

Nuisance from domestic smoke can be overcome only by the abolition of the open fire burning soft coal and the substitution of heating by gas or electricity or the use of central heating. Smokeless fuels, such as anthracite, coke, coal carbonised at low temperatures, and oil, should be employed where possible.

The law relating to nuisance from smoke is set out on p. 545, and it should be noted that the expression " smoke " includes

soot, ash, grit and gritty particles. It is the duty of local authorities to deal with this form of nuisance and a model bylaw has been issued for their guidance. At present it is considered impracticable to apply standards to any but black smoke, and the model bylaw presumes a nuisance if black smoke be emitted from one chimney of a building other than a private dwelling-house for two minutes in the aggregate within any continuous period of thirty minutes. This standard is not yet practicable in every district.

The standards adopted for use by the inspectors of the Sheffield, Rotherham and District Smoke Abatement Committee are as follows :—

Where there is 1 boiler attached to a chimney, 2 minutes per hour.

Where there are 2 boilers attached to a chimney, 3 minutes per hour.

Where there are 3 boilers attached to a chimney, 4 minutes per hour.

Where there are 4 or more boilers attached to a chimney, 6 minutes per hour.

Where there are 1 or more boilers and 1 or more furnaces attached to one chimney, 6 minutes per hour.

The National Smoke Abatement Society through its branches assists local authorities in the provision of classes of instruction for firemen, boiler attendants, engineers and others, and helps in various other ways. A useful handbook on smoke abatement may be obtained from this Society. (See also Shaw and Owens : " The Smoke Problem of Great Cities," London, Constable & Company, 1925.)

Industrial processes. Objectionable effluvia may be given off in various offensive trades (see p. 547), and in other trades dust and dangerous gases may escape into the surrounding air.

VENTILATION

Ventilation may be defined as the " science of maintaining atmospheric conditions which are comfortable and healthful to the human body." As people nowadays tend to congregate in large numbers in schools, factories, places of amusement and even in dwellings, the problems of ventilation have received a great deal of attention in recent years. The old ideas that the discomfort experienced by the occupants of ill-ventilated rooms was due to lack of oxygen, to excess of carbon dioxide or to some organic poison in the expired air were refuted by Sir Leonard Hill (L.G.B. Report, New Series, No. 100, 1914 ; Medical Research Council Reports, No. 32, 1919 ; and No. 52, 1920).

Hill conducted certain experiments in a hermetically sealed

chamber in which the composition of the air could be absolutely controlled. In this he enclosed several students, and found that they remained quite comfortable when the percentage of oxygen was lowered below 17 (when a match could not burn). A reduction to less than 19 per cent. is practically never noted in occupied rooms, while at heights of 5,000 feet and over, where people live and thrive, the oxygen content of the air is much lower. "So long as there is a partial pressure of oxygen sufficient to change most of the hæmoglobin of the venous blood into oxyhæmoglobin during its passage through the lungs, there can arise no lack of oxygen." "A person not exerting himself will fail to observe any effect until the oxygen has been reduced to 12 or 10 per cent., and consciousness will not be lost until the percentage sinks below 7."

The CO_2 in an atmosphere never increases to any great extent. About 0·04 per cent. is normally present in outside air, while in overcrowded places like theatres and lecture-halls the figure may be 0·3 or 0·35 per cent. It is only when concentrations of 3 per cent. and over are breathed that respirations become noticeably increased. In submarines men can work in atmospheres containing as much as 3·5 per cent., and in the fermentation rooms of breweries amounts varying from 1·5 to 2·5 per cent. have been detected.

With regard to the organic poison theory, Hill and Flack kept animals alive and healthy in the bottom of deep boxes so arranged that at least 1 per cent. CO_2 was present at all times, and consequently a great deal of breath exhalation as well. No evil results followed.

Hill pointed out that, while evidence in favour of the chemical view was lacking, there was convincing proof that heat stagnation, due to excess of moisture and lack of air movement, was the cause of the discomfort. In the experimental chamber already mentioned, students were exposed to a wet-bulb temperature of 82–85° F. (the dry-bulb reading being a degree or two higher), a percentage of oxygen less than 17 and a CO_2 percentage of from 3 to 4. While the air was still, considerable discomfort was experienced, but great relief was obtained when electric fans in the roof were set in motion. "The same stale air, containing 3–4 per cent. CO_2 and 16–17 per cent. oxygen, was whirled, but the movement of the air gave great relief because the air was 80–85° F. (wet-bulb), while the air enmeshed in their clothes in contact with their skin was 98–99° F. (wet-bulb). The whirling away of this stationary air cooled the body effectually, for air can hold considerably more water vapour at 98–99° F. than at 80–85° F. The symptoms arising in the so-called vitiated atmosphere of crowded rooms are dependent on heat stagnation. The essential thing is to keep down the saturation of the air in contact with the skin. The air entangled

in the clothes becomes warmed up to body temperature and saturated with moisture if there is no wind to drive it away."

A desirable atmosphere is cool rather than hot; dry rather than damp; and moving rather than still. Thus, ventilation and warming (or cooling) are closely connected, and, indeed, the two must usually be considered together. For comfort and general well-being the rate of heat-loss from the body should be adequate, but not excessive. Heat is lost by radiation, convection and evaporation, and the environmental factors on which this heat-loss depends are the temperature, humidity and velocity of the air, and the temperature of the surrounding surfaces (walls, etc.). If the warmth of an environment is to be completely specified, all these factors must be taken into account. At ordinary room temperatures (up to 70° F. or rather more) considerable changes in humidity have but little effect on comfort; it is only when the air becomes very dry or very moist that unpleasant sensations arise. At higher temperatures humidity becomes increasingly important. Until quite recent years it has been usual to specify only the air temperature, or the temperature and humidity, but various methods have been devised for allowing for the effects of air temperature along with those of other thermal factors in a single index.

The Kata-thermometer. Hill's kata-thermometer gives an indication of rate of heat-loss, or the cooling power of the air. It is a spirit thermometer with a large bulb, and with distinctive marks on the stem at 95° F. and at 100° F. The thermometer is warmed to well above 100° F. and then suspended in the desired position, and the time taken in cooling from 100° F. to 95° F. is observed. For each instrument there is determined a factor (marked on the stem) proportional to the total heat lost per square cm. of the bulb in cooling from 100° F. to 95° F. When this factor is divided by the number of seconds taken in cooling, the quotient is known as the "cooling power." The heat-loss is measured in millicalories per square cm. per second (1,000 millicalories = 1 gm. calorie = one-thousandth part of a large Calorie). Observations may be made using the thermometer as a dry-bulb or as a wet-bulb instrument. The dry kata cooling power combines the heat-losses due to radiation and convection, and the wet kata cooling power adds to these the loss by evaporation. From a knowledge of the dry kata cooling power and the air temperature (dry-bulb), the air velocity can be calculated. In this way air currents as low as about 10 feet per minute can be measured with considerable accuracy. In the presence of much radiant heat a silvered kata-thermometer should be used for the estimation of air movement. The effect of wind on the rate of heat-loss by convec-

tion is much influenced by the size of the cooling object, a given increase in air movement having a greater effect in the case of a small object, such as the kata-thermometer, than in that of a larger one, such as the human body. Because of this sensitivity of the kata-thermometer to air currents, if the same cooling power is observed in two environments it does not necessarily follow that the thermal effect on a man will be the same. Nevertheless, the kata-thermometer has been found to be a useful index of warmth. For the study of ordinary room conditions the dry kata-thermometer is generally used, while the wet kata is of value in warm atmospheres, *e.g.* in the tropics, cotton mills, and deep mines, when sweating comes into play. Hill recommends that for sedentary workers the dry kata cooling power should be not less than 6, and the wet kata not less than 18. For more active work higher cooling powers are desirable. Vernon suggests that much depends on the particular processes being carried on by the workers and how far they have got used to the conditions.

The eupatheoscope and equivalent temperature. The need for an instrument which, while taking account of radiant heat, would correspond approximately to the human body in its sensitivity to air currents, led to the development of the eupatheoscope (Building Research Board Technical Paper No. 13, 1932, Dufton). This instrument is a hollow, blackened, copper cylinder, 22 inches high and 7½ inches in diameter, which is heated electrically. The surface temperature of the instrument is maintained at a temperature which is lower than 100° F. by two-thirds of the difference between 100° F. and the temperature of the environment, being 80° F. for example in an environment at 70° F., and 70° F. in an environment at 55° F. This corresponds approximately with the average surface temperature of the clothed human body. The readings of the eupatheoscope are given on a scale of equivalent temperature. The equivalent temperature of an environment is that temperature of a uniform enclosure, with still air, in which the eupatheoscope would lose heat at the same rate as in the environment under consideration, the surface temperature of the eupatheoscope being maintained as described above. Equivalent temperature therefore gives an index of the combined effects of air temperature, air movement and radiation. This index should not be used at temperatures higher than about 75° F., for at such temperatures changes in humidity must be taken into account. The eupatheoscope is essentially a laboratory instrument, but in field studies equivalent temperature can be estimated from globe thermometer temperatures (*vide infra*).

Effective temperature. Another scale of warmth widely

used in the U.S.A. is that of effective temperature. This scale gives a measure of the combined effect on the human body of the temperature, the humidity and the movement of the air. It is an empirically determined index dependent on the sensations of human subjects, and may be defined as "that temperature of saturated, motionless air which would produce the same sensation of coolness as that produced by the combination of temperature, humidity and air motion under observation." No allowance is made for radiant heat, and some correction is necessary if the effects of, say, open fires or cold walls are to be taken into consideration.

The globe thermometer. For ordinary room conditions, when there is not much air movement, the reading of Vernon's globe thermometer (*J. Indust. Hygiene*, Vol. 14, p. 95, 1932) gives a good index of the combined influence of air temperature and radiant heat. This instrument is a blackened, hollow copper sphere, 6 inches in diameter, containing an ordinary thermometer with its bulb at the centre of the sphere. There is no provision for heating the globe. Its temperature depends solely on the environment in which it is placed, and lies between the temperature of the air and the mean temperature of the surroundings (walls, etc.).

If the air temperature and air velocity are measured in addition to the globe thermometer temperature, it is possible to estimate from these readings (*a*) the mean temperature of the surroundings, or the mean intensity of radiation, and (*b*) the equivalent temperature. (*J. Hyg.*, December, 1934, p. 458, Bedford, T., and Warner, C. G.)

Comfort standards. In the appropriate circumstances any of these measures will furnish a good index of the sensation of warmth, but the equivalent temperature scale is the most widely applicable. In ordinary rooms, where there is little air movement, the globe thermometer temperature is a good index, and under such conditions the kata-thermometer is a useful standard. Provided there are no appreciable radiation effects the effective temperature scale is applicable. In many buildings the heating is by hot water "radiators," or other convection methods, and in such places, when there is little air movement, the air temperature itself is a sufficiently good guide. (Industrial Health Research Board Report No. 76, 1936, Bedford.) For persons in this country who are doing very light work the most comfortable degree of warmth is that producing an equivalent temperature of 62° F. In the conditions mentioned above, this comfortable warmth is obtained with a globe thermometer reading or an air temperature of 65° F., an effective temperature of 61° F., or a dry kata-thermometer cooling power of 6. Owing to differences in climate and clothing, warmer conditions are required in the U.S.A. There it is found that for persons

normally clothed and slightly active an effective temperature of about 66° F. is most suitable (*J. Hyg.*, September, 1939, p. 498, Bedford, T., and Warner, C. G.).

Air supply and cubic space. Ventilation should not give rise to objectionable draughts. At about 60° F. an air current of 1 foot per second is perceptible to most people, and at a greater velocity a sensation of draught is experienced. Generally, air should not enter windows or other openings at a speed exceeding 4 feet per second, but if it is sufficiently warmed and enters overhead a higher speed may not be objectionable. The smaller the area of the inlet the more likely is an unpleasant draught to be created.

The amount of fresh air to be admitted to a room depends on the size of the room and the number of occupants. It is said that the air of a room should be changed at least six times per hour. Sir Leonard Hill has suggested that 1,000 cubic feet of fresh air per head per hour is sufficient provided there is air movement. Recent American work shows that a minimum of about 720 cubic feet of fresh air per hour is necessary to keep down unpleasant body odours where "sedentary adults of average socio-economic status" are housed with 300 cubic feet of room space per person. The number of persons who should be permitted to occupy a given space is laid down in various bylaws, regulations, etc., in respect of specified premises (see table).

	Minimum space.	Authority.
Common lodging-houses (sleeping-rooms).	40 square feet for persons over ten, and 30 for those not exceeding ten years.	Model Bylaws.
Factories. . .	400 cubic feet . . .	Factories Act, 1937.
Basement bakehouses .	500 do. . . .	Home Office Order of Dec. 30, 1903.
Army barracks .	600 cubic feet, 60 square feet of floor space, and 6 linear feet of wall space.	British Army Regulations
Army hospital wards .	1,200 cubic feet, and 100 square feet of floor space.	Do. do.
Public elementary schools .	12 square feet of floor space over eleven years, 10 square feet for infants.	Board of Education.
Canal boats (persons under twelve years)	40 cubic feet . . .	Regulations under the Canal Boats Act, 1877.
Canal boats (persons over twelve years).	60 do.	Do. do.
*Seamen's cabins . . .	120 do.	Merchant Shipping Act, 1906.
Hop and fruit, etc., pickers .	20 square feet (2 children under 10 count as 1 person)	Model Bylaws.

N.B.—Certain standards in relation to the abatement of overcrowding have been laid down in the Housing Act, 1936, see p. 630.

* The Board of Trade in 1937 issued a useful memorandum entitled "Instructions as to the Survey of Master's and Crew Spaces."

It must be remembered that the amount of floor space per person is a better standard than the amount of cubic space, just as the number of linear feet of wall space per bed is important in the case of hospital wards, barracks and school dormitories. If cubic space is being calculated it is just as well to neglect any measurement of height over 12 feet. These figures, of course, have reference to rooms ventilated by ordinary natural means. In theatres, where as many as twenty persons per 100 square feet may have to be accommodated, special systems of ventilation have to be employed.

Natural ventilation is dependent on three natural forces :—

(*a*) **Diffusion.** Graham's Law states that the rate of diffusion of gases varies inversely as the square roots of their densities. Thus oxygen with a density of 16 diffuses at only one-fourth of the rate of hydrogen with a density of 1. As most materials used for house construction are more or less porous, a slight amount of interchange of indoor and outdoor air takes place in this way. Varnished wallpaper, painted walls, panelling and heavy curtains tend to reduce such interchange.

(*b*) **Winds** may act either by perflation, as when the doors and windows of a room are thrown open, or by aspiration, as when wind blowing over the top of a chimney exercises an upward suction effect on the air in the flue. Winds are, however, irregular in action. There may be no wind at all, or else a wind of such force that it is difficult to control.

(*c*) **The movement of masses of air of unequal temperature.** Hot air is lighter than cold air, and as it rises it is replaced by a current of colder, heavier air. This is one of the chief forces at work in natural ventilation. The greater the difference of temperature, the greater will be the velocity of the incoming air. On this principle depends the ventilating power of our ordinary coal fires.

All private houses and most schools and factories in this country are ventilated by natural means. In summer the action of the wind is mainly relied upon, but in winter more dependence is placed on the difference in temperature. Air enters a room mainly through windows and finds an exit to a large extent by the chimney flue where one is provided. The commonest and probably the best aid to ventilation is the open fireplace and flue. The sectional area of the flue of an ordinary open fireplace is about 80 square inches. The ventilating value of this when a fire is burning at the bottom is obvious, but the flue is a valuable aid to ventilation at all times as the velocity of air currents across the top has an aspirating effect and air currents in the flue are nearly always in an upward direction. The modern gas fire which is so frequently fitted in place of the coal-fire grate has a canopy or hood above the flue socket, so that the heated air and the products of combustion passing up

the flue carry with them air drawn in from the room through the canopy opening.

The model bylaws made under the Housing Act, 1936, require every habitable room to have one or more windows capable of being opened at the top and to at least one-third of the extent of each window and opening directly into the external air. If there is only one window, or if there are more than one but they are situated in the same wall of the room, the total area of window space must be equal to at least one-tenth of the floor area of the room, otherwise the total area must be at least one-twelfth of the floor area. In addition every habitable room must be provided with means of ventilation either by a properly constructed flue or by an aperture or air shaft having an unobstructed sectional area of at least 30 square inches (at least 50 square inches in London).

Cold in-coming air has a tendency to flow down the wall of a room and pass across the floor to the fireplace unless some means are adopted of deflecting it upwards and enabling it to mix with the warmer air of the room.

Windows in common use are of two kinds—double-hung sash windows in which sashes work up and down on pulleys in a frame, and casement windows in which the sashes are hinged on the sides of a frame. In sash windows it is possible to have one or other of the sashes fully open or both partially open, but there can never be more than one-half the whole area of the window open at any time. The inside of the frame of a window of this kind is often fitted at the bottom with a board about 6 inches wide known as a deep window bar which makes it possible, by raising the lower sash, to have the window open at the middle where the two sashes meet, while leaving it closed at the bottom where in-coming air might give rise to a feeling of draught. In the modern casement window the sashes are hung

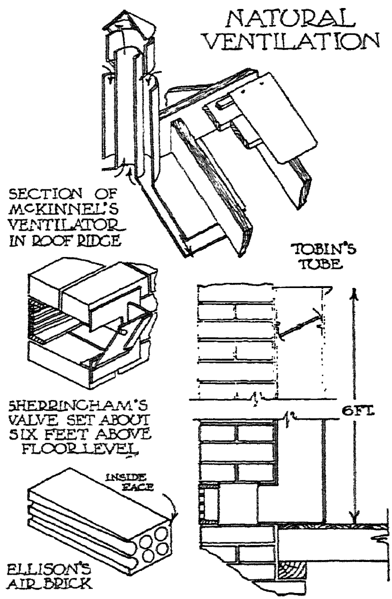

FIG. 7. Ventilation Openings.

at the sides, opening outwards and in opposite directions. This type of window can be opened to the extent of its whole area, or one or other of the sashes can be opened as required according to the direction of the wind. A sash hinged along the top is usually added ; this also opens outward and can be used with safety even during heavy rain.

Many devices have been used as adjuncts to window ventilation. These are chiefly in the form of hoppers fitted in one or more of the panes falling inwards and having side gussets to prevent draught, or panes having a series of openings regularly arranged within a circle which may be closed by a revolving glass shutter. The best means of permanent ventilation for use in rooms in which the window area is insufficient or which are not provided with a fireplace and flue is the ordinary air-grating, provided it is of sufficient size. Wall openings fitted with mica flap valves of various kinds to allow air to pass in one direction only are of little value, and the same may be said of sheet-metal tubes provided with shutters for regulating the passage of air through them.

A low-pressure hot-water heating system may be utilised to assist the natural ventilation of a building if radiators are placed immediately before openings in the external walls, preferably at floor level, and below the windows. The inward passage of air through the openings is assisted by the convection currents set up in the room, and the temperature of incoming air is slightly raised by contact with the radiator.

Roof ventilators are commonly provided in factories and sheds, *e.g.* louvres in the ridge, hinged sections in the glazed portion of the roof, or extraction shafts. Such roof ventilators, although meant to be exits, may tend to act as inlets and produce down draughts. Extracting appliances of the revolving-cowl type are apt to get out of order, but certain kinds of fixed cowl are satisfactory.

The air of a room can be set in motion and greater comfort given to the occupants by the use of fans. The most generally serviceable are circulating fans, and the oscillating portable type which can swing to and fro through a considerable angle is specially useful. Others may be suspended so as to rotate on a vertical spindle and propel the air downwards.

In order that adequate air circulation should be permitted around buildings model bylaws require that all carriage ways shall be at least 36 feet wide, and all roads not to be used as carriage ways at least 24 feet wide and open at one end. At least 150 square feet of yard space must be provided at the back of, and must belong to, each building. Back-to-back houses are prohibited, save in the case of tenements where the medical officer of health certifies that the arrangement is such as to secure effective ventilation of all habitable rooms. In

building schemes it is customary to allow only twelve houses to an acre in urban areas and eight in rural.

Mechanical ventilation. In many modern buildings it is necessary to supply a definite quantity of air to the occupied rooms, and mechanical means of producing air movement are essential. It is obvious that such means may extract air from a room or impel air into a room, or both impel and extract.

An extraction system is of service mainly in factory premises, and is most useful in cross-ventilated narrow rooms. The air entering the room to replace the air extracted should be as dust-free as possible. If the extract outlets in the room are at a low level, the air should enter the room through inlets 8–10 feet high. If the outlets are at a height, then inlets should be about 4 feet above the floor. In cold weather it is advisable that the incoming air should be warmed by radiators or steam pipes. Localised exhaust ventilation is essential for the removal of fumes and dust in various trade processes. Extraction should be arranged at a point as near as practicable to where the fumes, etc., are generated, and in such a manner as to draw them away from the operative and not, for example, past his mouth and nose. The extraction force is always one or more fans, and a system of ducts conveys the dust or fumes to some central point or points in the factory. A suitable velocity of the air discharged from the ducts must be maintained and this may be measured by an anemometer (a sort of speedometer). The velocity so read in feet per second multiplied by the area of the duct in square feet gives the volume of air discharged in cubic feet per second. The kata-thermometer may also be used as an anemometer. Another measuring apparatus is the Pitot tube, which indicates the pressure due to the velocity in a duct by means of a U-tube manometer. The reading is in inches of water, and the velocity of the air may be calculated by formula.

In the plenum system, where air is forced into a room, better control of the entering air is, of course, possible. The fresh air pushes out the vitiated air, draughts are avoided, the volume of the air admitted can be regulated, and by means of filters, batteries of radiators and wet screens the air can be cleaned, warmed and moistened (" conditioned ") as may be required. The best form of plenum system provides air at approximately room temperature and leaves the warming of the building to radiators. In other installations the incoming air is used to make good some of the heat loss, and is introduced at a temperature rather higher than that of the room. Radiators are provided as well, but only to such an extent as will make good some two-thirds of the heat loss, the warmed air supplying the other third. In still other instances the entering air is made to supply all the heat and no radiators are provided at all.

This is sometimes referred to as the "hot blast system." In all these cases it is common to arrange inlets and outlets on the inside wall of rooms, the inlets in the wall being near the ceiling and the outlets near the floor.

The most satisfactory system of mechanical ventilation is, however, where both propulsion and extraction of air are employed. By means of careful regulation of the air velocities as many changes of air per hour as desired may be obtained and all sensation of draught can be avoided. This is the method used in most theatres and places of amusement. In crowded rooms the problem of ventilation is largely one of air-conditioning. Even in cold weather the heat given off by the occupants is greater than any heat loss from the building, and the air introduced must therefore be drier and cooler than the air already in the theatre. Air is usually admitted through decorative features in the ceiling, and is extracted through openings in the floor placed under the seats. If the temperature of the air introduced is very much below that of the air already in the theatre, a sensation of draught will be produced, and to avoid this devices are obtainable nowadays for extracting a certain volume of air from the theatre, filtering it, mixing it with freshly conditioned air and returning the mixture to the theatre.

The success of a system of mechanical ventilation depends in large measure on the careful planning of the ducts through which the air is propelled. A great deal of resistance is offered by friction—increasing as the speed of the air increases. Friction is also increased by lengthening ducts, by bends, by sharp-angled connections, by sudden enlargements or contractions of ducts and by rough surfaces.

In this country opinion is generally in favour of using natural systems of ventilation wherever possible. (*J. of Hygiene*, March, 1940, pp. 125–53, "Measurements of the Ventilation of Dwellings," Warner, C. G.; "Modern Air Conditioning, Heating and Ventilating," Carrier, Cherne and Grant, Pitman Publishing Corporation, 1941.)

Air Sterilisation. There are two principal methods of killing pathogenic organisms in the air of a room. One is by means of ultra-violet light and the other of bactericidal mists. Ultra-violet light of wavelengths of 2,537 angstrom units is highly bactericidal. The effective waveband, however, is very limited and this method is capable of use only in such cases as operating theatres or specially constructed schoolrooms.

Much attention has been given in recent years to the possibilities of bactericidal mists. Sodium hypochlorite in a dilution of 1 part per five million of air is definitely lethal to organisms of the respiratory tract, and provision was made for the use of this type of aerial disinfection in certain of the

more crowded shelters during the period of heavy air raids in London.

Propylene glycol, a dihydric alcohol $C_3H_6(OH)_2$ closely related to glycerine, kills bacteria of the respiratory tract present in air in dilutions of 1 in four million. Its action is most potent at relative humidities of 40 to 60 per cent. Triethylene glycol is still more effective. When these chemicals are used for aerial disinfection they must be distributed through an atmosphere in fine particles of about 1–2 microns in diameter. It is thought that their action is due to the bombardment of bactericidal particles by aerosol droplets. Aerosol mists or sprays may be produced by means of a variety of apparatus, *e.g.* the Dynalysor, the Phantomyst, Shepherd's Volatilizer.

The whole subject is still very much in the experimental stage, but it is possible that aerial disinfection of rooms may yet become a matter of great practical importance. (*Science*, 4th June, 1943, Vol. 97, No. 2527, pp. 495–502, " Air-borne Infection," Robertson, O. H.).

If it is desired to **examine the efficiency of the ventilation** of an occupied room, the following points should be borne in mind :—

(*a*) Make the visit at the time of maximum contamination, *e.g.* in a sleeping apartment just before the occupants rise. Note the " sense-impression " ; count the number of occupants, gas burners alight, open windows and any other air inlets ; note presence or absence of chimney flue.

(*b*) Measure the room.

(*c*) Take wet- and dry-bulb thermometer and dry kata-thermometer readings, and measure the equivalent temperature.

(*d*) Estimate the percentage of CO_2 in the air by Haldane's portable apparatus. (The Departmental Committee, 1902, on Factory and Workshop Ventilation recommended that the proportion of CO_2 should not exceed, during daylight, 12 volumes per 10,000 volumes of air, or after dark, if gas or oil is used for lighting, 20 volumes per 10,000. As the outside air contains approximately 4 volumes of CO_2 per 10,000, any considerable excess of CO_2 indicates insufficient exchange of air.)

On the outbreak of war many factories and other premises were hurriedly " blacked-out " and in some cases ventilation was so restricted as to endanger the health of the workers. The Factory Department has issued a useful pamphlet on the subject (Form 301, 1941, " Factory Ventilation in the Black-out ").

(" Health and Environment," Hill and Campbell, Arnold & Co., 1925 ; " Heating and Ventilation," Allen and Walker, 1931 ; M.R.C. Reports, No. 32, 1919, No. 52, 1920, No. 100, 1926 ; Welfare Pamphlet (Home Office), No. 5, 1937, " Venti-

lation of Factories and Workshops"; Indust. Health Res. Bd. Pamphlet No. 1, 1943, "Ventilation and Heating, Lighting and Seeing").

HEATING

Heat passes from one body to another by radiation, conduction and convection. Radiant heat is transmitted in straight lines, and the intensity of radiant heat is inversely proportional to the square of the distance from the source of heat. Radiant heat does not appreciably warm the air through which it passes. Conduction is the passage of heat from one body to another in contact with it. Metals are good heat conductors; other substances such as wood, asbestos and felt are poor conductors, and so act as insulators. In the phenomenon of convection, air, for example, when heated by contact with a warm surface, becomes less dense and therefore rises, allowing the cooler heavier air to take its place. On the convection currents set up many systems of heating and of ventilation depend. Most heating appliances give rise to both radiation and convection, though in widely differing proportions. A comfortably warm temperature for sedentary persons is considered in this country to be about 65° F. An air temperature of 55° F. with a radiant heat source of the necessary intensity will also be found to be comfortable. The unit of heat is that amount required to raise the temperature of 1 lb. of water 1° F. This is known as the British Thermal Unit or B.Th.U. The "therm" employed as a basis of charge in the gas industry is a unit of 100,000 B.Th.U. (about 200 cubic feet). The unit in electricity has a heat value of 3,412 B.Th.U.

Heating systems may be classified as follows:—

(*a*) Open fires.
(*b*) Stoves.
(*c*) Warm air furnaces.
(*d*) Steam — pressure. / vapour. / vacuum.
(*e*) Hot water — low temperature gravity. / pressure. / forced circulation.
(*f*) Mixed heating and ventilation.

(*a*) **Open fires** warm chiefly by radiation. The best type of fireplace should have some means of regulating the area of the throat of the chimney flue and an adjustable air-inlet beneath the fire. Diminution of the depth of the grate from front to back adds to the radiation efficiency, a depth of about 4 inches being the feasible minimum. The sides of the grate should slant towards the back. Firebrick should be used wherever possible and the amount of iron reduced to the smallest extent practicable. Even with the best patterns of grate radiation,

efficiency is not likely to exceed some 30 to 35 per cent. of the theoretical energy of combustion (Fuel Research Board, Technical Paper, No. 13, 1925). These open fires, if ordinary bituminous coal is used, are apt to be dirty and wasteful, but they aid ventilation considerably and add to the cheerfulness of life in a country where the winter climate is damp and chilly. Smokeless fuels such as coke and the products of low temperature carbonisation, such as "coalite," will prove satisfactory in most modern fireplaces, especially if a supply of gas is available to ensure easy lighting. Special open grates may now be obtained in which anthracite may be burned. The modern gas fire is a great improvement on its predecessors—it is now so constructed as to aid ventilation, and its radiation efficiency is about 45–50 per cent. Although satisfactory flueless gas heaters are obtainable, it is preferable to use gas fires connected with flues. Electric radiant heaters have many hygienic advantages. They warm by radiation and to some extent by convection, and no products of combustion enter the room. They are, however, rather expensive. The radiation efficiency of some high temperature open-wire heaters is as high as 70 per cent. In recent years electrically heated panels have been used for warming rooms. In one type of installation panels measuring 6 feet by 2 feet are fixed round the edge of the ceiling and maintained at a temperature of 90°–125° F. They are usually controlled by a thermostat set to provide a given air temperature. The current is kept running continuously night and day in most cases and the cost is rather heavy. In other cases fire-clay plates containing a heating element are suspended from the ceiling and walls. These plates may be raised to as high a temperature as 500° F. This system is also expensive, and in one school investigated Crowden found the conditions incompatible with comfort and efficiency (*J. of Hyg.*, Vol. XXXIII., No. 2, 29th April, 1933, pp. 151–164).

(*b*) **Stoves** are used mainly for heating halls and large rooms where systems of central heating are not available. They heat by radiation and convection, and have a higher efficiency than the open fire. Anthracite and coke are the favourite fuels for such stoves. Care must be taken to see that no products of combustion escape save by the flue to which the stove must be attached. Where stoves are used for heating huts, steps should be taken to ensure that the dampers are provided with an aperture of sufficient size to allow fumes and smoke to escape *via* the flue pipe, even when the damper is in the closed position (Ministry of Works Circular, 8th April, 1943. "Slow Combustion Stoves"). The disadvantages are that a stove is required for each room and that if placed centrally in a large hall a stove occupies valuable space. In certain types

arrangements are made to warm incoming air led from the outside by a duct.

(*c*) **Warm air furnaces** are not used to a large extent in this country, though their popularity is increasing. A furnace is placed in the basement of a house and air taken from the outside is passed over the surfaces of the furnace and carried through pipes to the various rooms. In the " pipeless " type the heated air is delivered only to the room directly above the furnace, and thereafter circulates naturally through the rest of the house. Great care should be taken to see that the system is designed in such a way as to prevent dust and gases from the fire entering the rooms.

(*d*) **Steam heating** is not so popular in this country as in the United States of America and its use is confined mainly to factories. Steam is led by pipes to radiators, where it is condensed, and arrangements must be made for the removal of air from the system and for the return to the boiler of the condensed water. In the older systems the radiators were usually heated to an excessive temperature, and regulating valves had to be attached to the radiators. Dust particles settling on these overheated radiators are volatilised and rather offensive odours given off. More recently steam heating has been improved by the introduction of what are known as vapour or vacuum systems. In these a separate set of pipes carries away the air and the condensed water from the radiators, and the steam circulates at very low pressure—very little above that of the atmosphere. In the vapour system the flow along the suction pipes is due to the pressure of the entering steam, but in the vacuum system a suction pump is used to reduce the pressure in the return pipes and so aid circulation. If a pressure lower than atmospheric is maintained in the radiators by reducing the amount of entering steam and by operating the suction pump, the temperature of the steam will be lowered and the heat given off by the radiators lessened. This system is especially useful in very large buildings.

(*e*) **Hot water heating** is the favourite form of central heating in this country. The flow of hot water through pipes and radiators may depend entirely on gravity—hot water being lighter than cold—or may be aided in large buildings by mechanical means, in which case rather smaller piping may be used. The temperature of the radiating surfaces may be anything from room temperature to 190° F., or even higher if hot water under pressure is used. The usual difference in temperature between flow and return is 20° to 30° F. In private houses the water is heated directly in a boiler surrounding a small furnace, but in larger buildings steam is generated in boilers and passed through coils of pipes in calorifiers, where it heats the circulating water to the necessary

temperature. An expansion tank must be provided at the highest point in the system. This tank is usually open to the atmosphere. If, however, a closed tank is placed at a lower point on the circuit and filled partly with air and partly with water, or if a special pressure valve is provided, the system becomes a "closed" or "pressure" one, and the temperature of the circulating water can be raised above 212° F. The usual form of hot-water heating is, however, the open system at low temperature. High temperature water heating is used mainly for factories and large buildings.

An installation suitable for private houses is known as the "indirect" hot-water system. Here one boiler is made to heat water for radiators and also water for ordinary domestic use. A primary circulation from the boiler passes through a coil in a cylinder and there heats the water for the domestic hot-water supply. The radiator circuit is connected with, and is really an extension of, the primary circulation, from which it may be shut off by valves when radiator heating is not required.

In large halls, hospital wards and other similar places lengths of piping may be employed in place of radiators, but radiators are in more common use. The situation of radiators in a room is an important matter, and, on the whole, radiators placed beneath windows give the best results. It is important to remember that a black surface gives much higher heat emission than does a highly polished metal surface. Radiators should never be painted with bronze or aluminium paints unless it is desired to economise in heating.

Concealed pipes in the ceiling may be used in place of radiators. Coils of steel pipes of ½-inch internal diameter are embedded in the plaster of the ceiling, and with a flow temperature of 137° F. and a return temperature of 120° F. the plaster surface has an average temperature of about 100° F. The heat from the panels is almost wholly radiant. Owing to radiation the floor surface of a room so heated is slightly warmer than the air above it, and some of the heat is conducted through the ceiling material and warms the floor immediately above. As concealed pipes are difficult to repair, exposed panels are sometimes used.

Underfloor heating is used in a number of schools. Low temperature hot water is run through 2-inch pipes set 16 inches apart under the floor of the room. The pipes are supported 2 inches above the concrete layer beneath the floor. Three inches above the pipes is the floor of the room composed of concrete slabs ⅞ inch thick, over which is a layer of granwood tiles in cement. The floor is kept at a temperature of 63° to 76° F. On investigation it was found that when the floor was at 72° F. the air 6 inches above it was

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54·5° F. and the air at head level 52·3° F. Heating in such a system is due largely to convection, but partly also to conduction through the soles of the feet and partly to radiation. In various investigations Vernon concluded that floor heating has a distinctly greater influence on warmth than the low temperature ceiling panel system. The warm floor is pleasant to the feet if the surface temperature does not rise much above 70° F. Ceiling panel heating and underfloor heating tend to cool heads and warm feet in contradistinction to certain other heating systems in use (*J. Indust. Hygiene*, Vol. 12, 1930, pp. 281–289, Vernon, H. M.). Vernon and Bedford found that in floor-heated schools, where the floor had a temperature of 63°–76° F., the skin temperatures of the children (as estimated by a Moll thermopile) were 1°–5° F. warmer than in a stove-heated room. In rooms heated by ceiling panels, the temperature of which was 112° F., children had a skin temperature on an average 1° F. warmer than in a room heated by convected air. A slightly lower cooling power is apparently consistent with comfort in panel-heated rooms. The temperature of schoolrooms has a very definite effect on manual dexterity—too marked a cooling power means loss of efficiency. Absence of children from school is considerably influenced by temperature. Vernon and Bedford found that the mean absence between November and March was 8·9 per cent. in schools kept at 63·4° F., 11·1 per cent. in those kept at 58·5° F., and 11·6 per cent. in those at 55·7° F. At unheated open-air schools absence was much affected by temperature, and during a very cold spell only half the children attended. The investigators concluded that this absence was not due to ill-health but to the restraining action of the parents. Ceiling heating in schools is considered by Vernon to be preferable to floor heating for most purposes, but not for open-air schools. Neither system is free from defect unless it includes a small amount of hot-water radiator or pipe heating in addition to counteract down draughts from windows. (Industrial Health Research Board, Report No. 58, 1930, " A Study of Heating and Ventilation in Schools," Vernon and Bedford.)

" For continuous heating in small rooms, hot-water radiators fed from a coke-fired boiler are the most economical method of heating; but, as the size of the room increases, open coke or coal fires become cheaper, especially when there are only a few people in the room. This is because, when air heating is employed, the whole of a room must be warmed, however few the occupants, whilst, with radiation heating, people can gather around a small fire whatever the size of the room. For intermittent heating, say, when a room is actually in use only for four hours per day, hot-water radiators remain the cheapest for small rooms with more than one or two occupants, but for

larger rooms, especially when sparsely occupied, open coal or coke or gas fires become the cheapest. For longer periods of use the advantage of open fires over air heating is less pronounced, for shorter periods it is more pronounced.

"When the circumstances are such as to preclude the occupants of a room from gathering together in the zone of comfort produced by an open fire, say, for instance, in an office or in a school where the desks must be more or less evenly distributed over the floor area, this method of heating becomes impracticable, and air heating must be substituted. This is especially the case when large rooms are in question. In this case hot-water radiators are usually the cheapest method of heating. An open fire on each wall, in conjunction with some air heating, would, however, probably be more comfortable, were it feasible.

"Whatever the method of heating adopted, the cost will be closely allied with the completeness of insulation of the rooms, and it is of the greatest importance to construct houses in such a way as to avoid high conduction losses. The losses through windows, for example, can be reduced to about half by double glazing, and a substantial reduction in the heat flow through brick walls is effected by the introduction of an air space between the two thicknesses of brick. The major portion of the energy liberated in a room by hot-water radiators, or other convection heaters, is spent in making good the conduction losses which take place through the boundaries of the room, and relatively little energy would be required to maintain the temperature excess of the air in the absence of this mode of outflow.

"The case of the open fire is somewhat different, as in general a much magnified rate of ventilation is produced by this form of heating, and the temperatures reached in the room are comparatively low. Conduction losses are, therefore, reduced, but the advantages of effective insulation are still very considerable" (Fuel Research Board, Technical Paper No. 12, 1925, "The Heating of Rooms," Fishenden, M.; *J. Inst. Heating and Ventilating Engineers*, April–May, 1942, pp. 17–64, "The Comparison of Heating Systems," Dufton, A. F., and Marley, W. G.; Indust. Health Res. Bd. Pamphlet, No. 1, 1943).

LIGHTING

The following definitions will enable readers to understand the terms used in the rather specialised literature relating to illumination :—

1. **Candle-power.** The unit of intensity of the light source is the international candle as agreed by the three national laboratories of Great Britain, France and the United States of America in 1909. This unit is maintained by means of incandescent electric lamps in these laboratories. The original

standard candle was made of sperm wax, burning 120 grains of spermacetti per hour.

2. **Foot-candle.** This is the unit of intensity of illumination received on a surface and denotes the illumination received at a point 1 foot distant from a source of one candle-power. Another unit employed is the **lux**—values of illumination in lux may be converted to values in foot-candles by division by 10·76.

3. **Lumen or unit of light flux.** The lumen indicates the amount of light emitted by a lamp, and may be defined as the amount of light falling on a surface of 1 square foot in area, every point of which is 1 foot distant from a light source of one candle-power. One lumen per square foot is therefore equal to one foot-candle.

4. The **brightness** of a surface results from the quantity of light it emits either by virtue of its self-luminosity, as in the case of the incandescent filament of an electric lamp, or by virtue of the reflection of some of the light it receives. The brightness of a light source is called its intrinsic brilliancy and is expressed in candle-power per square inch.

Measurement of illumination. By international agreement the daylight illumination at any position in an interior is now evaluated according to its "daylight factor," that is the ratio of the actual illumination at the point in question to the illumination derived from a complete hemisphere of sky (taken as 500 foot-candles). The Waldram gauge, which measures the daylight factor directly, is a small portable apparatus, a description of which appeared in the *Bulletin of Hygiene*, April, 1932, p. 206. It has been suggested that the daylight factor needed for the minimum illumination of any school place should be 0·5 per cent. For the measurement of artificial illumination one or other of the various photometers or foot-candle meters must be used.

General considerations. Good lighting means (*a*) adequacy; (*b*) constancy and uniformity—absence of flicker; (*c*) absence of glare—a workman should never have to look directly at a bright light, nor should the rays of a bright light be permitted to enter his eye obliquely from the edge of his field of vision; light may also be reflected from a shiny or polished surface; here shading the source of light with some translucent material will often be of service; (d) avoidance of shadows—remedies are suitable shading or adjustment of the lamp or increasing the illumination over the part of the plane of work affected so as to neutralise the shadow.

Electric light is to be commended from every point of view. It is clean, adds no products of combustion to the air of the room and is easily led to any point requiring illumination. The most generally useful type of lamp for indoor use has a

drawn tungsten wire filament inside an opal or white bulb which has been exhausted of air and filled with an inert gas. Fluorescent tubular lighting gives better illumination intensities without increasing current consumption. It gives a cool light of low surface-brightness with a pleasing daylight effect, and shadow formation is greatly reduced. The inside of the tube is coated with fluorescent powder and filled with mercury vapour which takes the place of the wire filament in ordinary incandescent bulbs. The initial cost of fluorescent lighting is higher than that of other systems but the running costs are low. High pressure discharge lamps are now often used for industrial lighting. These lamps contain mercury, sodium, or mixtures of gases and vapours, and in their present stage of development give more or less unnatural colours. Their advantage is a very high output of light for the electrical energy expended. Coal-gas lighting gives excellent results so far as illumination is concerned, but it is not so clean as electricity, it warms the air of a room considerably and its combustion may give rise to certain undesirable products. The only satisfactory type of burner is of the inverted type with a mantle suspended beneath. If neither electricity nor coal gas is available, acetylene gas, petrol gas or paraffin-oil lamps may have to be used. There are obvious objections to all of these, but reasonable illumination may be obtained if a satisfactory installation is provided and adequate attention paid to its maintenance.

In the Electric Illumination Bulletin Handbook No. 2B, issued by the Lighting Service Bureau, the following intensities of illumination are recommended :—

	Foot-candles
Hospitals :	
Corridors	3
Wards and private rooms	3
Operating table	100
Operating theatre	12
Laboratories	10
Dentist :	
Waiting-room	5
Surgery	12
Hotel :	
Lounge	6
Dining-room	6
Writing-room	8
Kitchen	8
Bedrooms	5
Corridors	3
Library :	
Reading-rooms	10
Bookrooms	5

	Foot-candles.
Offices :	
General	10
Private	8
Typing and book-keeping . . .	10
Filing-room	8

Industrial processes : 5–50, according to the fineness of the work.

(*Bulletin, Health Organisation, League of Nations*, Vol. VII, Extract No. 11, 1938 ; *Trans. Illum. Engineering Soc.*, June, 1939, "Daylight Factors for Efficient Working and their Predetermination," Angus, T. C.; Indust. Health Res. Bd. Pamphlet No. 1, 1943.)

Dwellings. No standards have been laid down for dwellings. In the *Manual on Unfit Houses* issued by the Ministry of Health in 1919 it was stated in respect of houses for the working classes that "it is essential that living-rooms should not be so dark in ordinary daylight as to hinder domestic work without artificial light and to make it difficult to see whether the rooms are clean." Under model bylaws habitable rooms must in certain cases have a total window space equal at least to one-tenth of the floor area. The intention of this is, however, rather to provide adequate ventilation than to secure efficient lighting. The bylaws also require that every staircase must be provided with adequate means of lighting by natural light.

Factories. More attention has been paid to lighting in factories, and it is possible to show that bad lighting affects the worker adversely (eye-strain, mental irritation, greater liability to accidents, unclean habits, lack of good order and discipline), and also the quality and quantity of the work. Processes requiring fine or delicate work need good lighting, and if any part of a process is delayed owing to unsatisfactory lighting the cumulative effect may represent a real financial loss to the factory. When work has to be done by artificial light there is frequently a falling off of output as compared with output under conditions of natural lighting. Thus the reduction has been shown to amount to approximately 11 per cent. in linen weaving, 10 per cent. in silk weaving and 5 per cent. in cotton weaving where coarse material is used (Industrial Health Research Board, Reports No. 9, 1920, No. 20, 1922, and No. 23, 1923). In an investigation into the relation between illumination and efficiency in type-setting by hand it was found that there is "an optimum value of illumination for hand composing which is of the order of 20 foot-candles. With such a value, provided by a well-planned installation designed to secure approximate uniformity of illumination over the whole area of work, it may be expected that the daylight rate of output will be maintained, at any rate, for the short periods which normally require the use of artificial light during the winter months.

The interests of employer and worker alike are seriously affected by inadequate lighting of composing rooms. If the illumination is less than 2 foot-candles, nearly one-quarter of the possible output is lost, and there is an unnecessarily high percentage of errors. In most of the larger munition factories lighting installations which give an illumination of 30 or 40 foot-candles have been provided. The use of fluorescent tubular lamps (see p. 435) has proved most satisfactory. If work is done in artificial light only for a few hours a day, there is no evidence that any undue ocular fatigue is likely to result, providing the illumination is uniform and of the order of 10 foot-candles. The provision of higher values of illumination is largely an economic question, which the results of this investigation show to be well worthy of consideration. If work has to be done continuously in artificial light, as in newspaper offices, the provision of higher values of illumination appears to be essential, if the efficiency of a night shift is to approach that of a day shift." ("The Relation Between Illumination and Efficiency in Fine Work (Type-setting by Hand)," Joint Report of Industrial Fatigue Research Board and Illumination Research Committee, 1926.)

The Factories (Standards of Lighting) Regulations, 1941, are somewhat revolutionary in their requirements. Briefly these are :—

1. The general illumination over all those interior parts of the factory where persons are regularly employed shall be not less than 6 foot-candles measured in the horizontal plane at a level of 3 feet above the floor. (There are certain exceptions allowed where the lights have to be high or where the plant offers obstruction.)

2. The illumination over all other interior parts of the factory over which persons employed pass shall when and where a person is passing be not less than 0·5 foot-candle measured at floor level.

3 Where any source of artificial light in the factory is less than 16 feet above floor level, no part of the source or of the lighting fitting having a brightness greater than 10 candles per square inch shall be visible to persons whilst normally employed within 100 feet of the source, except where the angle of elevation from the eye to the source or part of the fitting as the case may be exceeds 20 degrees.

4. Any local light, that is to say an artificial light designed to illuminate particularly the area or part of the area of work of a single operative or small group of operatives working near each other, shall be provided with a suitable shade of opaque material to prevent glare or with other effective means by which the light source is completely screened from the eyes of every person employed at a normal working place, or shall be so placed that no such person is exposed to glare therefrom.

5. So far as reasonably practicable, arrangements shall be

made, by suitable screening or placing or other effective method, to prevent discomfort or injury by the reflection of light from smooth or polished surfaces into the eyes of the worker.

6. Adequate measures shall be taken, so far as reasonably practicable, to prevent the formation of shadows which cause eyestrain or risk of accident to any person employed.

These Regulations have done much to bring home to industry lighting needs which hitherto were not properly realised. In a number of factories there have been low intensities of lighting and glare from exposed or insufficiently screened electric bulbs. Old lamps, dirty reflectors, dirty walls and ceilings are found in many factories and account for much bad lighting. The proper arrangement of lighting points and the provision of suitable modern reflectors result in more effective lighting conditions.

The Illuminating Engineering Society has published an exhaustive Code of "Recommended Values of Illumination" (revised June, 1941) for a very large variety of trades and crafts and this is now almost universally accepted. See also, Home Office Factory Dept. Form 1983, October, 1937, "Industrial Eyestrain"; *Illuminating Engineering*, December, 1941, pp. 1414–36, "Lighting Large Factory Areas with Fluorescent Lamps," Taylor, G. J.; *Trans. Illuminating Engineering Soc.*, February, 1943, pp. 17–32, "Proposals for New Lighting Code," Weston, H. C.

Schools. (*a*) **Natural lighting.** Satisfactory natural lighting at any point in a room depends on (*a*) the amount of sky visible from the point in question, (*b*) the transmission of the window glass, (*c*) the amount of light reflected from the walls and ceiling of the room. It is suggested that :—

1. A position in a classroom from which no sky is visible at desk or table height is not fit for use as a school place.

2. A minimum daylight factor of 0·5 per cent. should be insisted upon.

3. Windows for lighting desks should be to the left of the pupils. If this is impossible, windows to the right are the next best. Roof lighting is undesirable, and lighting directly from the front of the pupils or teachers is bad.

4. Window heads should be horizontal. Glass should be carried up to the ceiling level and not obstructed by large mullions, etc. Glass should be kept clean.

5. Ceilings should be white, and the walls above the dado should be light in tint. All dark shades in furniture and elsewhere should be avoided.

N.B.—Glare may be a very real problem in open-air schools and classes.

(*b*) **Artificial lighting.** (1) The minimum illumination on desks and tables should be (*a*) 5 foot-candles for ordinary

reading and writing and (*b*) 8 foot-candles for special work in art classes, drawing offices, workshops and sewing-rooms where dark materials may be used; on blackboards illumination should be 60 per cent. in excess of that on desks and tables; in assembly and recreation rooms 3 foot-candles; in no part of the building should illumination be less than 1 foot-candle.

2. Glare from the use of unscreened gas mantles or lamp filaments within the direct range of vision must be avoided, as must also reflected glare from polished or glazed surfaces. Blackboards should have dark matt surfaces,* and books should be printed on paper free from glaze.

3. Objectionable shadows must be avoided—diffused light will help in this respect.

4. A standard classroom (approximately 480 square feet) may be efficiently lighted by four suitable lighting units distributed symmetrically above the desks, but two additional units are frequently needed for the teacher and blackboard. Lights must be kept well out of normal line of vision—a minimum height of not less than 10 feet is desirable.

5. All lamps in lighting fittings should be cleaned and overhauled at least once a month.

The Board of Education (Educational Pamphlet No. 107, 1937) suggests the following as the approximate minimum general illumination in foot-candles required in working positions in various rooms:—

Room.	Intensity.
Classrooms . . .	10 at desk or table level.
Library	10 ,, ,, ,,
Crafts room . . .	10 ,, ,, ,,
Needlework rooms . .	12 ,, ,, ,,
Staff rooms . . .	10 ,, ,, ,,
Art rooms . . .	10 on the working plane.
Science rooms . . .	10 ,, ,, ,,
Housecraft rooms . .	10 ,, ,, ,,
Workshops . . .	10 ,, ,, ,,
Physical training rooms .	8 at floor level.
Assembly halls . .	8 ,, ,,
Dining-rooms . . .	8 ,, ,,
Corridors and staircases .	6
Cloakrooms, lavatories, etc.	6

Light should be so distributed that the ratio of illumination of the lightest to that of the darkest part of a room is not higher than 1·5 to 1, though it will usually be necessary to make special arrangements for lighting the blackboard.

* The use of primrose yellow boards and dark ultramarine chalk is recommended. ("Improving the Blackboard," W. Douglas Seymour, Nat. Inst. Indust. Psychology, 1938.)

SECTION VII

WATER SUPPLIES

Physical properties

WATER is the standard for purposes of comparison of the density of all liquids and solids ; at atmospheric pressure, and at the temperature of its maximum density, *i.e.* 4° C., its specific gravity is taken as 1·000. The weight of 1 c.c. of water at its maximum density is 1 gram, or 15·432 grains ; above and below 4° C. its density diminishes ; 1 gallon of water weighs 10 lb., and 1 cubic foot of water measures 6·23 gallons. At a temperature of 0° C. or 32° F. water freezes and expands nearly one-eleventh of its volume ; this explains why pipes burst and the hardest rocks disintegrate. In changing into ice, water gives up 80 calories of latent heat ; the specific gravity of ice is 0·9168, hence it floats.

In being raised to boiling point, water requires 1 calorie per gram per 1° C., and a further 537 calories to convert it into steam, which is nearly 1,700 times the volume of the water. At atmospheric pressure water boils at 100° C., but when the pressure is diminished it boils at a lower temperature, while if the pressure is increased the boiling point is raised.

Water has a very marked solvent action ; it dissolves all gases, and there are few solid substances that are not acted upon in time, the dissolved carbonic acid gas present in natural water assisting in the process. The solubility of gases in water depends on the pressure, and at ordinary pressure the amount is greater in proportion as the temperature is lowered. Solids in solution lower the freezing point of water (*e.g.* sea water) and raise the boiling point.

Water-bearing formations

One portion of the water deposited on the earth flows away on the surface, another part, amounting on an average to 25 per cent., is evaporated, and another portion percolates downwards, dissolving some of the mineral constituents of the rocks through which it passes.

The following are the chief water-bearing formations :—

Chalk. Skeleton shells of organisms which have secreted calcium carbonate ; the water is usually clear, wholesome, and sparkling, but hard.

Limestone. Masses of calcium carbonate; water wholesome and agreeable, but hard.

Oolite. Layers of calcium carbonate formed round some central nucleus.

Lias clay. Clay containing limestone; water variable in quality.

Soft sandstone rock. Loose sand and gravel; water variable in quality.

Millstone grit. Rock composed of silica; water generally pure.

Dolomite. Magnesium carbonate and calcium carbonate.

The most constant and abundant springs are in the chalk, oolite, new red sandstone, millstone grit, and mountain limestone.

Porous and permeable formations hold water throughout their mass and would yield a supply if tapped. The others may be considered impervious in mass but contain water in joints, fissures, and other cavities, and consequently become water-bearing only if a joint, fissure, or cavity is tapped. A fissure is a cavern produced by erosion or by the action of water containing free carbonic acid on such a stratum as chalk. If this action takes place in a superficial stratum, from the surface downwards, "swallow holes" are formed through which water is diverted underground. These constitute a danger, as gross pollution, unacted upon by the natural purifying agencies of the soil, may gain access to a drinking-water supply.

All geological formations, whether porous or not, are disposed either with horizontal stratification or with a "dip" or inclination in a certain direction. They may be bent into folds or saddles known as "anticlines" or in the form of basins, known as "synclines." By denudation and other processes the surface may be changed so that a valley may be over an "anticline," or a hill above a "syncline." The surface therefore is no indication of the underground formation. By contraction and pressure formations are liable to fracture, with consequent displacement either upwards or downwards. This dislocation or breach of continuity is called a "fault." The "throw," that is, the amount which represents the vertical displacement, may give rise to an "overthrust," whereby an older formation is thrust over a newer or where a stratum loses its continuity and becomes contiguous with a different stratum altogether. It is easy to imagine a fault causing a spring or to explain why one well yields a prolific supply and yet another only a few feet away little or none. The angle between the fault or plane of fracture and the vertical is known as the "hade." With the aid of a geological map one can often conclude that a water supply should be obtainable at a certain spot at a certain depth. Suppose that sand, clay, and lime-

stone come to the surface, that is, they "outcrop." It is obvious that they must dip or incline in one direction or the other. On consulting the "Key" of the strata on the side of the map one can learn which is the oldest formation, as the strata are invariably arranged in order of age. If, for example, the limestone is the oldest, it must run under the sand. In that way the direction of the dip is known. The following diagrams will make it clear :—

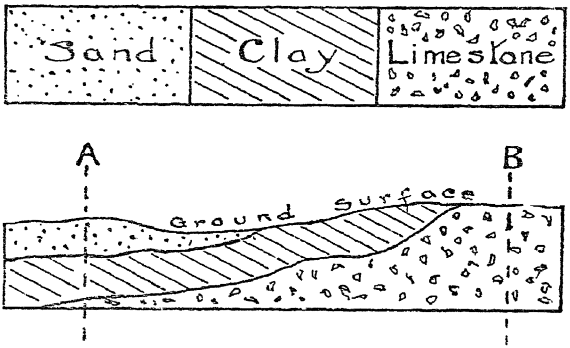


FIG. 8.

A well sunk at B would tap the water in the limestone. A well sunk at A would first tap the water in the sand resting upon the impermeable stratum of clay, but if sunk perhaps only a few feet lower, it would also tap the water in the limestone.

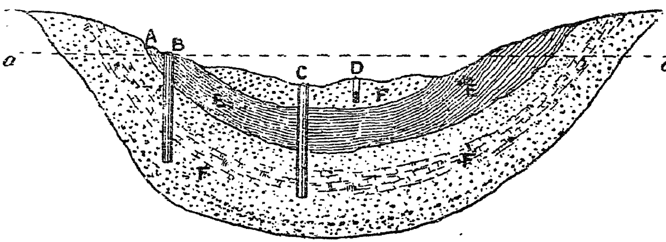


FIG. 9. *a . . . a*, plane of saturation or level of underground water in deeper pervious stratum, FF. B is a deep or sub-artesian well and C an artesian well, bored through the impervious stratum EE into the pervious stratum FF. D is a shallow well. F is the first pervious stratum.

The level of the underground water is known as the "plane of saturation" or "water table." It assumes the same curve as the surface of the earth above it, but to a less degree.

The characters of a water depend entirely upon the strata through which it has percolated. Deep-seated water is the purest as regards organic contamination, but even the clearest water may be dangerously polluted; more particularly is this the case with shallow well water and some springs. All waters contain in solution a certain proportion of gases and mineral matter. The amount of dissolved inorganic solids, as a rule, increases with the depth. Waters from the chalk, Silurian limestones, carboniferous and magnesium limestones, calcareous sandstones, oolite, and greensand are usually very hard on account of the calcium carbonate and calcium sulphate which enter into their composition. Greensand water is typified by its high saline ammonia content, the absence of, or very small amount of, oxidised nitrogen, and the comparative excess of chlorides. Soft waters are obtained from most upland surfaces, also from the Cambrian, Silurian, and Devonian slates, and from some of the sandstones and new red sandstone, if such are near the surface or find an outcrop. Water flowing over granite and gneiss is almost invariably pure and soft.

Sources of supply

1. **Rainwater.** The average rainfall in England amounts to about 34 inches yearly. In East Anglia the fall is about 25 inches; in the west it is much more. One inch of rain = 52 gallons per 100 square feet = 22,000 gallons per acre.

Rainwater is usually very pure in the country, but in towns it is apt to be contaminated with soot, acids and other impurities in the atmosphere. It contains certain dissolved gases, very little solid matter, and is liable to have a solvent action on metals. It is collected usually from roofs or specially prepared impermeable surfaces. A small house with a roof area of 500 square feet will collect 7,800 gallons in a year with a rainfall of 30 inches. This would provide over 20 gallons a day for the household. To estimate the number of gallons of water per year which a roof will collect, multiply the horizontal area of the roof in square feet by half the average rainfall in inches.

In country districts 5 gallons of water per head per day may be regarded as a minimum requirement. Storage for 1,000 gallons should be provided. The water should be stored, preferably underground, in a well built, protected cistern made of good cement concrete. If rainwater is to be used merely as an auxiliary supply, it may be stored in a galvanised iron tank placed above ground. A circular tank, 6 feet in diameter and 6 feet deep, holds about 1,000 gallons. (Ministry of Health Memo. 183W., June, 1934.)

2. **Upland surface water.** Such supplies are derived either from natural lakes in moorland districts or from "impounding reservoirs" constructed to collect water flowing off the adjoining

hills. It is customary in the case of moorland or upland sources of supply to provide storage for over 100 days. The area draining into the reservoir is known as the "catchment area." A catchment area may be accurately marked out on a 6-inch ordnance survey map.

This shows :—

(1) "Contour lines," or lines drawn through points of equal altitude at vertical intervals of 50 feet up to 100 feet, and thence at vertical intervals of 100 feet up to 1,000 feet.

(2) "Ridge lines," or lines drawn along the tops of watersheds.

(3) "Bench mark" figures indicating altitude to one decimal place, *e.g.* B.M. 100·5 means that the Bench Mark ⊼ cut on some stone is 100·5 feet above ordnance datum. Ordnance datum is the mean sea level at Newlyn, Cornwall.

The selected area should be well fenced in, any buildings and farms within it should be under the rigid control of the water authority. All water channels should be partially built up where necessary and kept clean. Any unsuitable feeders should be cut out, and provision made to prevent the entrance of turbid flood water into the reservoir. Such waters, if sufficiently protected, form satisfactory supplies. They are usually very soft and frequently show brownish discoloration. They may have a solvent action on lead.

3. **Rivers.** The character of river water varies according to the country through which it flows and the tributaries entering it. Most rivers in this country are grossly polluted by the discharge of effluents and in few cases, if any, is there sufficient interval between the points of discharge to permit of complete purification by natural means. Natural means are : (1) dilution, (2) oxidation, (3) sedimentation, (4) action of water animals and plant life, (5) sunlight. Weirs are sometimes placed in the course of a river to assist self-purification. Control must be exercised over all waters discharged into a river above the intake of a water supply, *e.g.* sewage works' effluents and trade wastes. That water from polluted rivers can be rendered safe by adequate treatment is instanced by the London supply, about 60 per cent. of which comes from the Thames.

The yield of a stream may be calculated by estimating the cross-sectional area in square feet and multiplying this by four-fifths of the surface velocity in feet per minute—the result will be cubic feet per minute. A gauging weir gives more accurate results.

Only a certain amount of water may be abstracted—a fixed amount, known as "compensation water," must be allowed to pass on for the benefit of persons living lower down.

Water is sometimes got from rivers by digging trenches parallel with the bank and at some little distance from the river. By these means water, more or less purified by filtration

through the intervening soil, may be obtained. Frequently, however, only the subsoil water percolating towards the river is tapped.

A great deal of attention is being paid to the increasing pollution of rivers in this country due to the discharge into streams of effluents from sewage works and of trade wastes. Fish life is being destroyed and the problem of obtaining water supplies from such polluted rivers is becoming more difficult. It has been suggested that the only satisfactory measure for dealing properly with river pollution is the establishment of special river boards charged with the supervision of rivers throughout the whole of their course. (Public Health, April, 1936, p. 251, Ash).

Three-quarters of the population of England and Wales are supplied with water from rivers, streams and springs, and the remaining one-quarter from wells and borings into water-bearing strata.

4. **Underground water.** Water lying above the first impermeable layer is known as subsoil or ground water. This water rises and falls according to the season of the year and the rainfall. It is normally highest in February and March and lowest in October and November, the rise being due to lessened evaporation and greater percolation. In addition, this water is always moving slowly towards its natural outlet either in springs, rivers or the sea, the actual direction depending on the dip of the strata. Such water, of course, collects any impurities that may enter it from the surface.

Natural means of purification in soil. By bacterial action in the upper few inches of the soil complex organic material is broken down into simpler combinations of its constituent elements C, N_2 and H_2. Nitrogen-oxidising organisms in the soil convert the ammoniacal nitrogen so formed to acid radicles which, in combination with existing bases, form nitrites and nitrates. This process is brought about by two groups of bacteria, the first converting ammonia to nitrites and the second completing the oxidation process by converting nitrites to nitrates, which represent the completely oxidised state of N_2. In addition to moisture, the bacteria which bring about the breaking down and subsequent oxidation processes require (1) oxygen, (2) suitable bases, and (3) a temperature of over 5° C. Unless these are present the disposal of organic matter cannot proceed to completion, and the humic acids, which represent the end products, cause souring of the soil. As will be seen later, it is necessary therefore that, when land becomes "sewage-sick," the provision of bases, *e.g.* lime, should receive consideration.

Ground water lying near the surface may thus become contaminated by organic matter that has not undergone sufficient natural purification.

Shallow wells tap the subsoil water, while deep wells tap some water-bearing layer below the first impermeable stratum.

Requirements of a good well. (1) Situated at least **100** feet away from any source of contamination such as a cesspool or manure-heap. The natural flow of the ground water should be from the well towards such source of contamination, never in the opposite direction. (*J. Infect. Dis.*, Vol. **61**, September-October, 1937, pp. 148–183, " Ground Water Pollution and the Bored Hole Latrine," Caldwell and Parr.) (2) An area surrounding the well should be railed off. (3) Water-tight lining

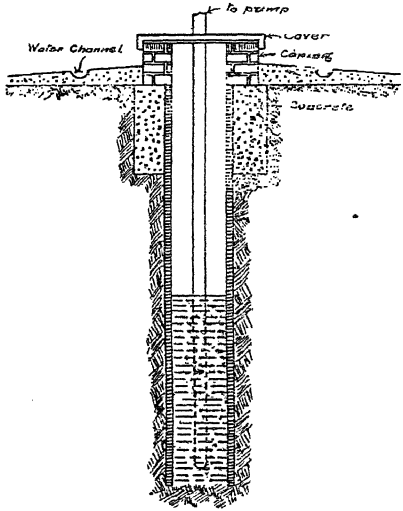


FIG. 10. Well, suitably protected.

to below water level of good quality bricks set in cement or pre-cast concrete cylinders. For large wells cast-iron lining is preferable but more costly. Any space between the well wall and the lining should be sealed by cement grouting. (4) The lining should be carried up as a coping 2 to 3 feet above ground and the well closed by a proper cover. (5) There should be a cemented area surrounding the well to a distance of at least 6 feet, with a fall away from the well. (6) If a pump is provided it should be placed a few feet away from the well and waste water should be conducted into a suitable drain. Existing wells that are unprotected may be made secure from surface pollution by a lining of concrete pipes set on end and cemented at the joints.

Tube wells consist of lengths of iron tubing driven into the

ground to the requisite depth. The first length is pointed and has perforations to allow of the entry of water. Water is raised by a pump attached to the top section. These form a rapid means of obtaining ground water, but in practice their use is limited to gravel or chalk subsoils and to places where water is rather less than 20 feet from the surface, except in the case of tubes large enough to accommodate a borehole pump.

The yield of a well may be reckoned by noting the sectional area of the bore and observing the time taken by the water to return to its normal level after being lowered by pumping to a known depth.

Subsoil or surface springs are natural out-croppings of ground water due to the approach of the first impermeable stratum to the surface. They are either constant or intermittent, depending on the rise and fall of the ground water. The same precautions must be taken as in shallow wells with regard to the protection of the site. The spring should be covered in and the water led by a pipe to a suitable reservoir. The yield of a spring may be estimated by finding how long it takes to fill a vessel of known capacity.

Deep wells yield, as a rule, more permanent supplies than shallow wells. The water is usually pure but is often hard. Such wells must be protected in the same way as shallow wells, and the water-tight lining should be carried down into the first impermeable stratum. Many wells have horizontal "galleries" driven into the strata through which they pass to tap additional water-bearing areas. A mechanically driven pump or water lift has to be employed to raise the water. In such wells surface pollution may enter through a fissure, *e.g.* in chalk, or through disused wells or boreholes which give direct access of surface water to the deep water-bearing stratum. Near the coast the water may show a tendency to become brackish.

If a source of contamination is suspected in the neighbourhood of a well, the following methods of examination may be adopted:—

Solutions of any of the following are poured on to the area supposed to be contaminating the well: a strong solution of common salt—an increase in chlorides may result; a strong solution of lithium sulphate—may be detected by spectroscope; an alkaline solution of fluorescein, *e.g.* 1 lb. of fluorescein and 1 lb. of caustic soda in 10 gallons of water—one part of fluorescein in 50 million parts of water can be detected in a 6-oz. medicine bottle and one part in 400 million in a clear cylinder lighted from the side in a black box. A suspension of *Chromobact. prodigiosum* may be similarly employed and later red colonies grown from the water.

In all cases the well should be pumped to waste thoroughly for some days before and after any of the above procedures is adopted, and the water entering the well examined daily.

An *artesian well* taps water which is held down by a superimposed impermeable stratum and which consequently is under pressure. When this stratum is bored the water rises in the bore hole to a height equivalent to the pressure. The term is usually applied to wells in which the water rises under its own head to surface level.

Deep springs may be regarded as natural artesian wells. They deliver water from a deep water-bearing stratum, usually through a geological fault. They may be polluted in the same way as deep wells. Some such springs are heavily charged with gases or saline matter and constitute the so-called medicinal springs.

5. **Distilled water** may be available, as an auxiliary supply, on board ships. It requires to be aerated before use, and, on account of its solvent action, it should not be allowed to come in contact with lead piping.

Minimum amount of water required per head per day in a town

		Gallons.
Household	Drinking	0·33
	Cooking	0·75
	Personal washing	5·00
	Dish and house washing	3·00
	Laundry	3·00
	W.C.	5·00
Trade purposes		5·00
Municipal	Street cleaning; Public baths, etc.; Flushing sewers; Fire extinguishing	5·00
Unavoidable waste		3·00
		30·08

A complete bath requires 30–40 gallons.
Horse allowance, about 16 gallons. Cow allowance, 10 gallons.
Hospitals, 40–50 gallons per head.
Office buildings, 15 gallons per head.
Day schools, 10 gallons per head.
The average daily consumption of water in London was 43·85 gallons per head in 1939.

Any water supplied must be chemically and bacteriologically pure and should not have a solvent action on metals.

The following comparison of water from different sources is given in the Report of the Commission on Rivers Pollution.

(*a*) Wholesome	1. Spring water 2. Deep well	Very palatable.
	3. Upland surface	Moderately palatable.
(*b*) Suspicious	4. Stored rain water	Moderately palatable.
	5. Surface water from cultivated land	Palatable.
(*c*) Dangerous	6. River water to which sewage gains access 7. Shallow well water	Palatable.

Comparison in order of softness :—

1. Rainwater.
2. Upland surface water.
3. Surface water from cultivated land.
4. Polluted river water.
5. Spring water.
6. Shallow well water.
7. Deep well water.

Purification of water on a large scale

Removal of hardness. Temporary hardness is due mainly to the bicarbonates of Ca and Mg and permanent hardness to their sulphates. Hardness is objectionable in that—

1. It is wasteful of soap (1 lb. of chalk consumes 9 lbs. of soap).
2. It deposits in pipes and boilers, forming a scale which may occlude the former or cause wastage of fuel in heating the latter.
3. It is alleged that it causes intestinal derangements and has some relation to rheumatism, gout and the production of urinary calculi.
4. It is not so satisfactory for horticultural purposes as soft water.
5. In the woollen industry it renders wool impermeable to dyes, while in public laundries the curd adheres to the articles, giving them a dirty appearance when finished.

It is the temporary hardness that deposits most readily, but at high temperatures and under pressure, sulphates crystallise out, forming a very hard and obstinate deposit. Boiler explosions may be caused by the sudden cracking of the scale and the subsequent contact of the water with the overheated metal of the boiler. The deposition of lime from hard water is trifling below 140° F.—quite hot enough for scullery water and 20° F. higher than is necessary for bath water.

Temporary hardness may be removed—(*a*) by boiling (impracticable on a large scale), or (*b*) by addition of lime, as follows :—

$$CaCO_3 . CO_2 + Ca(OH)_2 = 2CaCO_3 + H_2O.$$

The lime combines with any free CO_2 in the water, so that in practice more is required than is theoretically demanded. A useful working rule is—add 1 oz. of CaO per 700 gallons for every grain of temporary hardness (degrees Clark's scale) to be removed per gallon.

Clark's process consists of: (1) Addition of the necessary amount of lime, usually as 10 per cent. milk of lime—done frequently by a mechanical regulator. (2) Thorough mixing. (3) Sedimentation. (4) Drawing off the clarified and softened upper layer. Sedimentation is very slow, the precipitate of $CaCO_3$ settling at anything from $2\frac{1}{2}$ to 12 inches an hour : hence some sort of filtration through linen or fibre screens, or through

quartz, is usually adopted. Sedimentation alone would require a period of about twelve hours.

Permanent hardness may be removed by the addition of soda or caustic soda, with the formation of a harmless sulphate of soda—

$$CaSO_4 + Na_2CO_3 = Na_2SO_4 + CaCO_3.$$

In the case of a water containing considerable permanent as well as temporary hardness a mixture of both CaO and Na_2CO_3 is sometimes employed. A final small dose of sodium hexa-meta-phosphate prevents subsequent precipitation of calcium carbonate in the distribution system.

Base exchange. Various combinations of silicate of alumina and soda, as in the "Permutit" process, may be used for softening water on a large scale or for domestic purposes. When a hard water is filtered through such a medium, the Ca and Mg take the place of the Na which passes off in the outflow. Thus—

$$Na_2Al_2Si_2O_8 + CaSO_4 = CaAl_2Si_2O_8 + Na_2SO_4.$$

As the efficiency of the medium gradually lessens, it is necessary to restore it by passing through the filter a strong solution of common salt. By "mass action" the Na displaces the Ca and Mg. Thus—

$$CaAl_2Si_2O_8 + 2NaCl = Na_2Al_2Si_2O_8 + CaCl_2,$$

and the life of the filter is completely renewed.

For the removal of temporary hardness the lime process has the advantage over base exchange that both precipitant and hardness are removed, so that the dissolved solids in the water are correspondingly reduced.

Removal of organic pollution.

Methods—

1. Storage.	
2. Filtration .	Open sand filtration. Mechanical filtration.
3. Sterilisation .	Chlorination. Addition of excess lime. Ozonisation. Ultra-violet rays. Catadyn Silver

1. **Storage** should be considered a preliminary to some form of filtration. The results of storage are—

(*a*) In raw river water, artificially infected with large numbers of typhoid bacilli, 99·9 per cent. of the organisms are killed by one week's storage under laboratory conditions. In similar circumstances the vibrio of cholera cannot be detected in 100 c.c. of water after three weeks. (*b*) Stored under natural conditions, river water shows a reduction of 90 per cent. in the number of

coliform bacteria after three weeks' storage, and most of those that remain are atypical. (*c*) Some improvement is effected in the chemical composition of the water. (*d*) Sedimentation of suspended matters takes place with subsequent longer life of filter beds, provided that algal growths do not multiply too abundantly. (*e*) Four weeks' storage renders a water "safe" prior to filtration, it lessens risk should the action of the filters become faulty, prevents the necessity of drawing water from rivers when in flood, and so tends to "equalise" the water. During the winter months the large storage reservoirs are visited by numbers of water fowl, including seagulls, which are a source of contamination. Various devices have been tried to frighten them away, such as placing wires across at intervals, firing blank charges, etc.

Typhoid bacilli were isolated by Adams in two out of every ninety-six droppings of seagulls examined in the vicinity of a town where typhoid epidemics had occurred. (See *Medical Officer*, 28th April, 1928, p. 185, Adams, F. C. S.)

Growth of algæ in storage reservoirs may take place, especially in late spring. Unpleasant taste and smell may result, *e.g.* from *tabellaria*, *synura* and *dinobryon*. Small algal growths tend to be washed down on to filter beds and cause clogging. The usual treatment is the addition of 2–10 lbs. of copper sulphate per 1,000,000 gallons of water. This may be applied by towing a bag of the salt through the reservoir behind a boat. Care must be taken in distributing the copper sulphate, and for large reservoirs the courses taken are parallel in one direction, and then parallel in a direction at right angles to the first. On small reservoirs the courses triangulate the surface. It is better to use copper sulphate as a preventive, otherwise the dead decomposing vegetable matter may make the water unfit to use for some time. Chlorine in the proportion of less than 1 part per 1,000,000 is also effective though the inhibiting effect wears off, and if water is infected with new growth further development takes place. "Cuprichloramine," a mixture of chlorine, ammonia and copper sulphate, has been used by the Metropolitan Water Board with satisfactory results. Objectionable taste due to algal growths may be removed by dosing with powdered activated carbon one to five parts per million. The carbon is subsequently removed by the filters. If the water must be treated after filtration about 0·5 part per million of potassium permanganate may be used. Small reservoirs may be covered over to discourage such growths.

2. **Filtration.** In the purification of water on a large scale filtration through sand is practised almost universally. Two main types of sand filter are in common use, namely, slow sand filter beds which may be used alone or after primary rapid filtration, and mechanical filters. If slow sand beds are

used alone the rate of filtration should be about $1\frac{1}{2}$ gallons per square foot per hour. Primary rapid filters are mechanical filters used without coagulants and are worked at rates varying from 80 to 150 gallons per square foot per hour, according to the nature of the raw water. They remove the coarser suspended matter and enable the secondary beds to be worked at higher rates and for longer periods between successive cleanings than would be possible without their aid. Whether employed alone or after primary filtration, the principle of slow sand filtration is the same. The dual system is practised at the Metropolitan Water Board works at Kempton Park. Here the slow sand beds consist of 2 feet of sand on a bed of shingle from 6 to 9 inches in depth and a head of 4 feet of water. The speed of filtration is about 4 gallons per square foot per hour. Pipes are placed vertically in the sand to allow of escape of air when the beds are being filled and the filtered water is collected in channels on the floor and led to a filtered water well. The upper layer of sand gets coated with a slimy deposit of algal growths, bacteria, and organic matter of all sorts. The efficiency of the filter depends mainly on the mechanical action of this layer. The denser the film, the slower is the rate of filtration, and the greater the head necessary to ensure delivery of a given quantity of water. At intervals (usually of six to eight weeks) the top half-inch of sand must be removed, washed and replaced. The new film takes about three days to form during which time the water must be allowed to pass very slowly through the bed. In some instances the first water is allowed to run to waste. Should the filter crack, or the surface layer of sand get disturbed in any way, inadequately filtered water may pass direct to the mains. Filtration is usually followed by sterilisation. Rigid control must be maintained by frequent bacteriological examinations of the water.

Mechanical filters, owing to the absence of a biological film, require the use of a coagulant such as the sulphates of aluminium and iron and sodium aluminate. For the successful and economical use of coagulants correctly designed floc conditioning basins and settling tanks are required. The rate of flow, dose of coagulant and *p*H value of the water must be accurately controlled.

The dose of coagulant required varies from 0·5 to 6 grains per gallon. The adjustment of the *p*H value may be effected by the addition of lime or preferably soda ash which should contain 98 per cent. Na_2CO_3.

Coagulants hasten the deposition of suspended matter in the sedimentation tanks, the flow through which is so controlled as to allow sufficient floc to pass to the filters to form an artificial surface film.

In mechanical filters the filtering medium is contained in tanks or cylinders which, if open at the top, are known as gravity filters ; if closed, as pressure filters. The Paterson filter is one of the best known makes in this country, and a short description of a plant installed at Kilmarnock will illustrate its operation. In this instance suspended impurities and colouring matter have to be removed from the supply. Prior to filtration the water has added to it by automatic regulator, a small quantity of alumino-ferric to coagulate the colour and impurities, and a trace of lime to neutralise the acid tendency of the natural water. The water containing the reagents then passes through a reaction and sedimentation tank divided into compartments of a capacity equal to about three hours' flow. The next stage is filtration through rapid gravity filters, ferroconcrete boxes each measuring $24 \times 12 \times 9$ feet deep and giving a maximum speed of filtration of 72 gallons per square foot per hour. The filtering medium consists of specially graded Leighton Buzzard sand supported on graduated layers of pebbles ranging in size from grit to large stones. The filtered water is collected at the base of the filter by a system of perforated strainer pipes fitted with gunmetal nozzles to the number of about 2,000 in each filter. After flowing through white inspection boxes the purified water passes into a clear-water storage tank. The deposition of intercepted impurities gradually makes necessary a greater head of water above the filtering surface until a point is reached when it becomes essential to cleanse the filter bed. This is effected by thoroughly agitating the filtering medium for about two minutes with compressed air through a distributing system below the filter, the sand bed being broken up and the impurities loosened. A reverse current of filtered water following the air agitation floats the loosened impurities into a waste channel. Each filter unit can be cleansed and restarted to work within ten minutes, although the cleansed unit is prevented automatically from coming into operation for a few minutes longer, during which time the filtering film is formed on the surface of the bed.

Mechanical filters are cheaper to install than sand filter beds, they occupy much less space, they can be housed anywhere, and they give a very rapid delivery of water. It is claimed that with a rate of about 50 gallons per square foot per hour, working with a coagulant and under skilled supervision, they give as good results as slow sand filters.

3. **Sterilisation of water** aims at the destruction of all non-sporing organisms of intestinal origin.

(*a*) **Chlorination.** Chlorine has a powerful bactericidal action and, if present in low concentration, will rapidly destroy all vegetative bacteria in water. It may be added to water as bleaching powder or as a stable hypochlorite solution when

small quantities are treated, or as chlorine gas derived from cylinders of liquid chlorine when treating large quantities.

Bleaching powder method. Bleaching powder is an unstable compound containing, when fresh, about one-third by weight of available chlorine.

The necessary amount of bleaching powder should be mixed with water in a cement or wooden tank. Galvanised iron should be used only if coated with a bituminous paint, as the solution will rapidly erode the unprotected metal. The mixture should be allowed to settle and should then be added to the water in the required proportions. The strength of the solution must be estimated daily in order to avoid error.

Chlorine gas method. Pure liquid chlorine is supplied in steel cylinders or drums. It may be added to the water as gaseous chlorine and the dose accurately regulated by the use of some such apparatus as Paterson's Chloronome. Here a regulating mechanism discharges the chlorine gas at whatever rate is desired into a portion of the water before addition to the main supply requiring treatment. The super-chlorinated water may then be added to the main supply by means of a special perforated pipe suspended beneath the surface of the water in an aqueduct.

Whichever method is adopted, a filtered water usually requires not more than 0·25 part of chlorine per 1,000,000 parts of water. This means about 8 lb. of fresh bleaching powder or 2·5 lb. of pure chlorine per 1,000,000 gallons. A water containing iron salts, however, or one obtained from peaty gathering grounds and having a high oxygen absorbing capacity, may require six times as much. The period of time necessary for sterilisation depends on a number of factors including the temperature of the water and the efficiency of the mixing. Anything from twenty minutes up to several hours may have to be allowed.

Chlorination should be regarded as supplementary to, and not as a substitute for, filtration. All physically impure waters should, if possible, be filtered before chlorination, as a smaller and more constant dose of chlorine may then be used. Particulate matter, moreover, may not be penetrated by chlorine and sterilisation may therefore be incomplete. Chlorination is cheap and may be used to take the place of storage on a large scale. The method can also be rapidly introduced as an emergency measure in a district where an outbreak of typhoid fever has occurred due to an infected public water supply.

Super-chlorination and de-chlorination. Here a much larger dose of chlorine is given and the period of contact with the water reduced. At the end of the period selected the excess chlorine is neutralised by some such de-chlorinator as sul-

phurous acid gas, sodium sulphite or sodium thiosulphate. Super- and de-chlorination usually prevent taste troubles from arising.

Taste. A chlorinous taste is due to an excess of chlorine and may be removed either by reducing the dose of chlorine or by adding a de-chlorinator.

An iodoform or " chemist's shop " taste is sometimes detected in chlorinated water, and is due apparently to the combination of chlorine with minute quantities of certain bodies of a phenoloid nature. Such bodies may be present in the atmosphere (from gasworks or from imperfectly burnt coal), or may be traced to the tar-spraying of roads, or even to the coating applied to the interior of cast-iron mains. The reaction does not take place if the water contains a trace of ammonia or an unusual amount of organic matter. It is more common when small doses of chlorine are used. The addition of 2 to 8 lb. of potassium permanganate per 1,000,000 gallons may be used to prevent taste troubles. The permanganate may be added before, with or after the chlorine : it usually prevents the iodoform taste, and furthermore aids in sterilising the water.

Chloramine—a combination of chlorine and ammonia—is now widely used for the sterilisation of water. It is less affected by the presence of organic matter and its sterilising action is more prolonged than is the case with chlorine. Its only other advantage over chlorine is its ability to minimise the production of iodoform and chlorinous tastes. Its bactericidal effect is however, very much slower than is that of chlorine. Long contact is therefore necessary and its use should not be decided upon without careful consideration. Houston treated the London water supply with ammonium sulphate followed by gaseous chlorine (0·25 part per million) and Harold subsequently used gaseous ammonia instead of the salt. In whatever form it is used the ammonia should be added at a sufficient distance above the chlorinating point to ensure satisfactory mixing.

(*b*) **Excess lime** was advocated by Houston. The method consists in the addition to water of (1) sufficient quicklime to combine with the free CO_2 and any CO_2 present in bicarbonate combination, and (2) an excess dose of CaO amounting to about 1 part per 50,000. This will practically sterilise the water in from five to twenty-four hours. Any excess lime remaining after sterilisation is complete should be removed. This may be done by mixing sufficient water (purified by some other means) to combine with the excess of lime, or by converting the lime into the insoluble carbonate by passing CO_2 gas into the water. The process is cheap and reliable ; it softens hard waters, and, if so desired, hardens soft waters.

In an excess lime plant at Langford, where impure waters

from the Chelmer, Ter and Blackwater are treated, the following procedure is adopted :—

After storage for about ten days the water is measured and split up by a weir device into two portions, one of which is about six times the volume of the other. Aluminium sulphate is added to the larger portion in such amount as to provide on an average 1 part per 100,000 to the whole. The smaller portion receives cream of lime in such amount that when mixed with the aluminated water the whole has an excess-lime dose of about 2 parts per 100,000. The water is then thoroughly agitated for about thirty minutes in mixing tanks and allowed to sediment for about twenty-four hours. The precipitate which deposits includes temporary hardness, suspended solids, colouring matter and bacteria. This somewhat long period of contact with an excess of lime is necessary if a water of low bacterial content is desired. Free lime is bactericidal in its action. After passing through these contact tanks the water still contains free lime which is finally removed by injection into the water of CO_2 obtained from the combustion of metallurgical coke. In order to remove any possibility of taste trouble a dose of about 2 parts of powdered activated carbon per 1,000,000 parts of water is added at the same time as the CO_2. Another period of contact of about two hours is given and the water is finally passed through rapid sand filters at a rate of about 50–60 gallons per square foot per hour. The sludge from the settling tanks is dried in lagoons and then transferred to a lime-recovery plant where it is burnt. The resulting lime is re-used in the purification process. Excellent results are obtained, hardness being uniformly reduced below the limit of 15 parts per 100,000, and *Bact. coli* being regularly absent in 100 c.c.

(*c*) **Ozonisation.** In the presence of organic matter ozone gives up its third atom of oxygen and becomes O_2. While so doing it destroys bacteria, renders water potable, bleaches it, removes the majority of tastes and changes the colour of water to a light blue. It may be regarded as a substitute for chlorine in the treatment of a well-filtered water. An efficient plant is produced by the Paterson Engineering Company. The plant consists of an ozoniser, in which ozone is produced from the air by means of a high tension current, and of a sterilising tower to which water and ozone are admitted near the base. Thorough mixing takes place in the tower and the ozonised water is discharged from the top. It is said that, with electrical current at ½*d*. a unit, the cost of treating water is about 0·085*d*. per 1,000 gallons or approximately 7*s*. per million gallons. In this country ozone is being increasingly used for the purification of swimming-bath water (salt or fresh) and of domestic water supplies. It sterilises rapidly, and the treated water is highly acceptable in quality.

(*d*) **Ultra-violet rays** are germicidal without any chemical change apparently taking place in the water. Plants are available for the treatment of water by this method, but are not likely to be installed in this country for purification on a large scale.

(*e*) **Catadyn.** This name has been given to an activated form of silver which has been made to deposit on particles of sand. If water is passed through a filter of this Catadyn sand it becomes more or less sterile in from two to twelve hours. The water need not be kept in contact with the sand for long as the action continues after filtration. Indeed the treated water may be used to sterilise additional quantities of water up to about 75 per cent. of the original amount. The effective life of such a filter is quite long. The water must be clear in the first instance. A modified method is available in which the silver is deposited on electrodes through which an electric current is passed. The water in public swimming baths is being treated in this fashion and it is likely that the use of Catadyn silver may become more general. ("The Sterilisation of Water by Catadyn Silver," Public Works, Roads and Transport Congress, 1931, Suckling.)

pH value. The importance of pH value at various stages in processes such as water and sewage purification is well understood. The older methods of testing by litmus, titration, etc., require time, and results may be obtained that are not entirely reliable. In modern works, by means of an electrically operated instrument known as the Multelec, pH measurements to a high degree of accuracy are made continuously and recorded on suitable charts. The actual control and adjustment of pH is possible by the same instrument.

Purification of water on a small scale

(*a*) **Boiling** is possible only in the case of water used for domestic purposes and should be adopted as a precautionary measure in the presence of an epidemic of water-borne disease.

(*b*) **Distillation.**

(*c*) **Treatment with chemicals.** Chemicals used for the sterilisation of water will not rapidly penetrate large particles of infective material, and it is advisable to rough-filter or otherwise clarify the water before treatment.

Chlorine. Superchlorination followed by dechlorination is the best method for purifying small quantities of water. The chlorine may be conveniently obtained from bleaching powder, hypochlorite solutions or as tablets of chlorine preparations. Sufficient should be added to give a chlorine concentration in the water of four parts per million. After standing for not less than 30 minutes the water may be dechlorinated by adding sodium thiosulphate, which removes the taste of chlorine.

Halazone has proved to be a source of chlorine sufficiently stable for embodiment in tablets, and a convenient outfit is now used in the Army. The outfit consists of a bottle of white and one of blue tablets. Each white tablet contains sufficient Halazone to sterilise the contents of a water bottle ($1\frac{3}{4}$ pints) in 30 minutes, and each blue tablet contains sufficient sodium thiosulphate to neutralise the chlorine and thus remove any chlorinous taste.

Potassium permanganate. Add sufficient to render the water faintly pink for half an hour. This is used largely in dealing with suspicious wells during cholera outbreaks.

Precipitants such as aluminium sulphate—6 grains per gallon—clarify the water and carry down most organisms in the sediment, but cannot be relied upon to provide a safe water. (*J.R.A.M.C.*, Vol. LXXI, No. 5, November, 1938, pp. 289–317, " Purification of Water Supplies by Units in the Field," Mackenzie, E. F. W.)

(*d*) **Domestic filters.** Vessels containing charcoal or sand are sometimes used as household filters. Such filters are not protective against pathogenic organisms and serve only to clarify water or to remove traces of iron. They give a false sense of security and, if not frequently cleansed, they deliver water which is worse bacteriologically than the crude supply. Catadyn sand may, however, prove useful for the filtration of water on a small scale.

Berkefeld and Pasteur-Chamberland filter candles are hollow bougies, the former made of a diatomaceous earth known as kieselguhr and the latter of unglazed porcelain contained in a metal case and connected to a tap from which water is obtained under pressure. Delivery of water through a filter of this kind is necessarily slow. To overcome this the filter candles may be arranged in batteries in an apparatus comprising a receptacle in which the filtered water is stored and from which it may be drawn. The receptacle is hermetically sealed and, except when it is full, the filtering process goes on continuously. There is justification for the claim that these filters are germ-proof, but scrubbing of the Pasteur-Chamberland and cleansing in boiling water of the Berkefeld filter candles at intervals not exceeding seventy-two hours are necessary. Unless this is done organisms may grow through the pores of the porcelain and appear in the filtered water.

The " Metafilter " and the " Stella " filter represent a notable advance in the design and construction of pressure filters of the smaller type. In these filtration is through a bed of specially manufactured kieselguhr supported on a metal core. In the Metafilter the core is composed of a number of flat circular washers made of a non-corroding metal, strung over a fluted metal rod and secured by pressure applied from the ends.

The washers comprising the core are slightly indented on one side so that when they are in position and held tightly together, minute waterways are left between each washer and its immediate neighbours. One or more cores built up in this way are secured to a head plate and supported in a stout cylinder which forms the outer body of the filter. In the Stella filter the core is formed by a non-corroding metal wire closely wound on a suitable foundation. In each case a quantity of filter powder, normally $\frac{1}{5}$ lb. per square foot of filtering surface, is mixed with water and placed in the cylinder which is then closed and ready for use. In operation, the first water entering the filter passes through under pressure more or less freely, but the powder suspended in it is retained and quickly forms a bed of even thickness over the outside of the core. The clearing of the filtrate indicates that this has occurred and the filter is then in working order. The rate and efficiency of the filter vary according to the nature and fineness of the powder used. Filters with a rated output of 50 to 100 gallons per square foot per hour are suitable for domestic purposes and are found to remove a high percentage of *Bact. coli.* The last two filters described are easily cleansed and are now adopted by the military authorities for use in the field.

Distribution of water

Water is drawn from points at varying depths below the surface, but well above the bottom, of the storage reservoirs and is led through aqueducts, which may be open or closed, to the purification works. After treatment at the works it is pumped to the service reservoirs which should be covered to prevent all possibility of contamination and algal growth. Service reservoirs are situated on elevated sites or placed in specially constructed towers from which the water can be supplied by gravitation throughout the district. Wherever possible a " head " of at least 20 feet above the highest buildings in the district should be available in case of fire.

The principal trunk distributing pipes or " mains " may be of cast-iron, steel, asbestos cement or reinforced concrete. Cast-iron and steel pipes must be protected against corrosion both for purposes of preservation and for maintaining their normal discharging powers. The protective measures in common use are—

(1) Coating with a solution consisting of 4 parts of crude tar and 1 part of anthracene oil—applied by dipping the pipes into a bath of the mixture at a high temperature immediately after they are cast, or with similar bituminous preparations.

(2) The Bower-Barff process. In this the pipes are raised to a temperature of about 1,200° F. and subjected for five or six hours to the action of super-heated steam. This

produces a coating of black oxide of iron which, if not damaged, is a good protective coating.

(3) Cement applied centrifugally so as to form a lining to the pipe.

By any of these means rusting or corrosion of the pipe is greatly retarded, a more or less smooth interior is preserved and friction is diminished.

Cast-iron pipes are usually jointed with spun yarn and molten lead. The latter must be well caulked as it contracts on cooling. Flexible joints may be introduced in places subject to excessive vibration or where the surrounding ground, *e.g.* clay, is liable to be affected by climatic changes.

From the service reservoirs water is distributed by mains throughout the area. Water is supplied to individual premises from service mains by means of service pipes. That part of the service pipe which extends from a service main to the stopvalve in a street or where a stopvalve is not fitted, to the point at which such pipe passes the boundary of the street, is termed a communication pipe. The remainder of the service pipe which is not a communication pipe is called a supply pipe. Service pipes are connected to the top or sides of the mains so as to exclude rust, etc., deposited along the invert. These pipes, though partly under the public way, are private property and are laid at the expense of the owners. They are more liable to damage than any other part of the private system, and in order to ensure proper maintenance and to prevent contamination and waste of water it is becoming the general practice for water undertakers to assume responsibility for these pipes, provided they are laid in an approved manner in the first instance.

Where the use of lead is inadvisable, service pipes are constructed of galvanised wrought iron with screwed joints or of light gauge copper with compression joints. In recent years alloys of lead known as ternary alloys have come into use. One of these is composed of 98·25 per cent. lead, 0·25 per cent. cadmium and 1·50 per cent. tin. Pipes made of this alloy are useful in the distribution of corrosive waters. As their tensile strength is high, such pipes if above ground may be of a weight 30 per cent. less than that of ordinary lead pipes. Service pipes, where underground, should be placed at a depth sufficient to protect them from frost (usually 2 feet 6 inches). They should not be laid on or through polluted earth or in contact with any substance liable to have a corrosive action upon them. These pipes have frequently to be laid side by side with drains. There is no harm in this if both are sound but, in case of defect, polluted water may be drawn into the service pipe whenever a negative pressure is produced within it, which may happen daily in an intermittent service and must occur sooner or later in every system. Newly laid mains or old mains

which have been repaired or opened up for any other purpose should invariably be disinfected with chlorine and tested bacteriologically before use.

Water may be supplied either constantly or intermittently. In the latter case, after running for a certain number of hours, the supply is shut off every day. *A constant supply* is much to be preferred, drinking water can then be obtained direct from the main, and plenty of water is available in case of fire. Furthermore, pipes may be of smaller diameter, and the necessity for storage of water in tanks in individual premises is reduced to a minimum.

The disadvantages of an *intermittent supply* are :—

(1) Water must be stored in large quantities ; this is always undesirable.

(2) Water for drinking purposes must necessarily be drawn from storage.

(3) When the supply is shut off, negative pressure may develop in the main and, should a pipe be defective, pollution is liable to occur.

(4) Corrosion of pipes is more rapid.

(5) Delay may occur in dealing with outbreaks of fire.

Whatever system is adopted, arrangements should be made in the delivery area to keep water constantly moving. There should be as few " dead ends " as possible and these should be provided with scour valves.

Storage cisterns. A storage cistern should be of a capacity of not less than 25 gallons, and, if used as a feed cistern (*e.g.* to the hot-water apparatus) as well as for a storage cistern for other purposes, should be of a capacity of not less than 50 gallons. (Model Bylaws, Series XXI., 1939.) Storage cisterns are necessary for all purposes in the intermittent system. In the case of a constant supply they are required only for feeding the hot-water system and flushing-cisterns to the water-closets. Cold supplies to baths and bidets are also taken from storage. Water for lavatory basins in bedrooms and places from which water is likely to be drawn for drinking purposes should be taken from the main.

A storage cistern should be made of material which will not affect the water deleteriously—usually galvanised iron. The cistern should be situated in a clean, accessible, well lighted and well ventilated place. It should be provided with a close-fitting cover, and should never be connected directly with a water-closet or other similar fitting. There should be an overflow pipe of sufficient size discharging into the open air. A cistern used for the storage of drinking water should preferably be cleaned out at intervals. Bylaws place this duty upon the occupier.

Solution of metals by service water. Certain waters act on metals, with the result that these may be dissolved in varying

amounts. Suckling in his book, "The examination of Waters and Water Supplies," 5th Edition, 1943, has suggested the following figures as limits for potable waters: lead 0·05 part per 100,000, iron 0·05 part as carbonate, copper 0·14 part, zinc 0·5 part and manganese 0·02–0·04 part. There are no generally accepted standards, and Ingleson (D.S.I.R. Tech. Paper No. 4, 1934) gives a summary of various opinions on the subject. The general opinion seems to be that 0·03 part of lead per 100,000 is safe, 0·05 part is the maximum amount permissible and 0·07 part is likely in the long run to cause chronic plumbism.

The waters which act most markedly on lead are those drawn from moorland surfaces. The solvent power of such waters appears to be due to acidity. If a sufficient amount of carbonate exists in the water and practically no free carbonic acid, the lead oxide formed upon the surface of the lead is immediately converted into an insoluble lead oxycarbonate. If, however, only a trace of carbonate is present, some of the lead oxide which is formed passes into the water and, if the free carbonic acid is also very small in amount, makes the water turbid from the formation of oxycarbonate. If more free carbonic acid is present, the carbonate of lead remains in solution. Silica as an alkaline silicate prevents the oxidation of lead and, if present to an extent of 1 part per 100,000, tends to coat the lead with a practically insoluble silicate. Upland surface waters are not the only plumbo-solvent supplies although their liability to contain organic peaty acids makes them specially dangerous. Other waters containing very little silicate or carbonate, *e.g.* some of those from the Bagshot sands, may act vigorously on lead.

The following methods, or various combinations of them suitable for particular waters, may be used to prevent corrosion of lead and other metals :—

(1) Aeration.

(2) Addition of lime or soda ash.

(3) Addition of chalk and coagulation by alumino ferric followed by filtration.

(4) Addition of a solution of sodium silicate.

Laboratory tests frequently lead to the expectation that the last method may be the best, but this has not always been confirmed in large scale practice.

As an additional safeguard lead pipes may be replaced by pipes made of galvanised wrought-iron or copper.

Fluorine to the extent of 1 part per million in drinking water may cause mottled enamel (see p. 283). Recent experiments have shown that under certain conditions m-phenylenediamine resin takes up fluorine from solutions of sodium fluoride, but it is not easily removed when other salts usually found in natural waters are present.

Swimming baths

The pollution of the water of swimming baths is of three kinds: (1) particulate matter, including fragments of recently discharged mucus; (2) matters in solution; (3) bacterial pollution, which may be considerable, even in waters which appear attractive. In one instance after two or three days' use a sample of water taken from a bath yielded 4,000 organisms per cubic centimetre among which were found *Streptococcus fæcalis*, *Staphylococcus aureus*, *Bact. coli communis*, *Prot. vulgaris*, as well as a Gram-negative diplococcus occurring in normal saliva. The users of this bath, numbering from one to two dozen daily, were boys of an industrial school who washed thoroughly with soap and water before entering the water. The water was changed twice weekly, but no disinfectant was used. It will thus be seen that the fill and empty without treatment system is not sufficient to prevent gross pollution.

For swimming pools of artificial construction, both indoor and outdoor, filled with water from the main supply, the method of continuous rapid filtration combined with continuous treatment by chlorine or chloramine and aeration should be adopted. To obtain satisfactory results a modern plant of adequate size under proper supervision should be employed. The period of complete circulation should be short, *e.g.* not more than four hours for covered baths and not more than six hours for open baths. To secure efficient filtration it is necessary to add a coagulant such as aluminium sulphate or alumino-ferric in the proportion of 1 or 2 grains per gallon of water to be filtered, and a suitable alkali, such as soda ash, in sufficient quantity to correct the *p*H value of the water if necessary and to counteract the acidity resulting from repeated additions of alum. Chlorination should be continuous during the whole period of bathing and the dosage sufficient to maintain a strength of free chlorine in the pool itself of not less than 0·3 part per million or greater than 0·5 part per million (see Model Bylaws, p. 567).

It has already been pointed out that filtration through Catadyn sand or treatment by ozone may prove to be of service in the purification of swimming-bath water.

A municipal covered swimming pool should ordinarily be 100 feet long and 35 feet wide, with a depth of 3 feet at one end and of 7 to 9 feet at the other. The bath surround should be 4 feet 6 inches in width, sloped away from the pool and adequately drained. Open-air pools are usually from 100 to 165 feet long and 40 to 60 feet wide, with a surround 10 feet in width. A gutter for expectoration should be situated just above water level. A cleansing room containing showers and foot baths, so arranged that each bather must pass through a foot bath, should be placed at each access to the pool. Showers

should be provided in the proportion of about one to four dressing boxes. Each shower should have a liquid soap container. Sanitary accommodation should be so situated that it is easily noticed by each bather on his or her way to the pool and is not accessible from the pool without the bather's being obliged to pass through the cleansing room. There should be two w.c.'s for women and two w.c.'s and three urinals for men.

Fungus infection of the feet may be contracted in swimming baths. The use of foot baths containing 10–15 per cent. sodium thiosulphate solution or 1 per cent. sodium hypochlorite has been recommended (*B.M.J.*, 22 Sept., 1934, p. 541, Gray).

(Ministry of Health Report on "The Purification of the Water of Swimming Baths," 1929; *B.M.J.*, 30 Sept., 1933, p. 603, "Observations on the Examination of Swimming-bath Water," Hicks, Pulvertaft and Chopping; "Swimming Bath Water Purification," Wilkinson and Forty, 1934; Final Report of Departmental Committee of the Min. of Health on the Cost of Hospitals and other Public Buildings, 1938, pp. 88–99; *J. Inst. of Heating and Vent. Engineers*, Vol. 7, No. 75, May, 1939, p. 145, "Bath Water Purification," Macknell, W.).

Diseases associated with water

(*a*) Due to inorganic salts: diarrhœa and gastric disturbance from consumption of water containing excessive amounts of sulphates, etc.; poisoning from lead or other metals; fluorosis from the presence of fluorides (see p. 283).

(*b*) Due to insoluble inorganic matter: irritative diarrhœa from fine particles of sand, mica, etc.

(*c*) Due to vegetable matter: diarrhœa and gastric disturbance from excessive amounts of vegetable matter.

(*d*) Due to organic matter generally, *e.g.* entrance of sewage into water mains: diarrhœa (L. G. B. (P. H.) Report No. 108, 1915; Ministry of Health Report No. 41, 1927.)

(*e*) Due to specific organisms: typhoid fever—*e.g.* Guildford 1867, Sherborne 1873, Caterham and Red Hill, Worthing 1893, Maidstone 1897, Beverley 1904, Lincoln 1905, Basingstoke 1905, Bolton-on-Dearne, Ecclefechan 1931, Malton 1932, Denby Dale 1932, Croydon 1937. (The *Lancet*, 5th March, 1938, p. 567, "Water-borne Typhoid," Forbes; and 26th March, 1941, p. 389, "The Enteric Fevers," Scott.)

Dysentery, both bacillary and amœbic, and paratyphoid fevers.

Cholera—*e.g.* the celebrated case of the Broad Street pump, Soho, in 1854; also Hamburg in 1892.

(*f*) Due to parasites: ascaris, oxyuris, whipworm, hookworm, guinea-worm, filaria, flukes, leeches, bilharzia, etc.

(*g*) Goitre is thought to be associated with iodine deficiency (see p. 142). A water supply deficient in iodine may play

a part in the causation of this disease, though this is not universally accepted. Medical Research Council, Report No. 123, "Iodine in Nutrition," 1929, Orr and Leitch.)

Features of an outbreak of typhoid fever due to contaminated water supply. (*a*) "The period of invasion" usually lasts about one month. During this time a few cases will be notified. Mild cases are apt to be missed and a certain number of days or even weeks may elapse before other cases are finally diagnosed. There is frequently a prevalence of diarrhœa for two to three weeks before cases of typhoid fever begin to be notified.

(*b*) "The period of explosive outburst" lasts from two to three weeks. Many people are infected simultaneously. This is very characteristic.

(*c*) "The period of secondary infection" may drag on indefinitely. Most cases are infected from existing sufferers but a certain number of primary cases contracted from the water may still occur. Inquiry will show that in the early stages of the epidemic it is only those who have used the infected water who have suffered, and evidence will usually be forthcoming of persons developing the disease outside the infected area who visited the area during the period of infection and consumed water while there.

Emergency measures. Advise every one concerned to boil all water before using it for drinking, washing dishes, etc. Sterilise the water supply, and the water mains, with a solution of bleaching powder, sodium hypochlorite or chlorine.

Between 1911 and 1937 there occurred in England and Wales 21 outbreaks of disease, conveyed by public water supplies, of such gravity as to merit detailed mention in the Annual Reports of the Chief Medical Officer of the Ministry of Health. Pollution prior to storage and distribution was responsible for 13 of the outbreaks, 4 of the 13 involving overground supplies and 9 of them underground supplies. Pollution during storage occurred in 2 cases and during distribution apparently in 6 instances. The numbers of known cases of disease resulting from these outbreaks were: enteric fever, 1,237; bacillary dysentery, 2,800; and gastro-enteritis, 7,439.

Workmen to be employed in waterworks should be carefully selected and the clinical history of each, particularly with reference to enteric infection, should be investigated. Anyone attacked by illness associated with looseness of the bowels should be suspended from work until his recovery is complete, and medical examination shows that it is safe for him to return to work. Every new man proposed to be employed where there is risk of his contaminating the water should be submitted to a Widal test. If a positive result is obtained, he should not be employed unless bacteriological examination of his excreta on at least three occasions shows negative results as regards the

presence of pathogenic bacteria. Special precautions should be taken where work is being done in wells or headings. If possible the water should be pumped to waste, workmen should be provided with boots and overalls which should be cleansed with chlorinated water on every occasion before the men enter the well, and special pails, of a type which minimises the risk of splashing or overturning, should be provided for micturition when the men are working. Strict instructions should be given that any man wishing to defæcate must be brought to the surface and that micturition should take place only in the pail provided. Sanitary arrangements should be provided at the surface and so designed that any risk of the men's boots being fouled is avoided. The well should not be brought back into supply until the water has been proved to be safe by bacteriological analysis.

All new mains and those that have been undergoing repair should be thoroughly flushed with chlorinated water before being put into use (Ministry of Health Memo. 221, 1939).

Ice is liable to the same contamination as water, and is often prepared and handled in a very unsatisfactory manner. Typhoid fever has been traced to infected ice.

Examination of samples of water

For chemical analysis water should be collected in a Winchester quart bottle. The bottle should be rinsed with dilute acid and then washed thoroughly with good tap water. Before the bottle is filled with the sample, it should be rinsed once or twice with the water to be collected. The stopper should be carefully tied down and sealed, and the bottle should be labelled with the name of the collector, the date of the collection and with an identification number. It is advisable to send the sample to the analyst in a special wicker basket as expeditiously as possible. It should be accompanied by a letter stating the reason for the analysis, the rainfall for the previous twenty-four hours, any possible sources of pollution and, in the case of a well, the nature of the surrounding soil. The sample should be collected under the same conditions as water is drawn for drinking purposes. In a house the sample should be taken from the lowest tap, so that water having run the greatest risk of pollution in the house will be secured. A well should be pumped thoroughly for several minutes in order to sample as much of the drainage area as is likely to be drawn upon in the course of the day. In the taking of samples for bacteriological examination sterile glass-stoppered bottles holding about eight ounces should be used. If a sample is taken from a tap, the tap should be cleaned with a cloth and then thoroughly flamed. The water should be allowed to run to waste for a few minutes. Before the sterilised bottle is opened the neck and stopper should be

flamed with a spirit-lamp, the stopper removed with sterilised forceps, the bottle filled and the stopper again passed through the flame before being replaced. The samples should be despatched, if practicable, in a special ice-box, and should be examined in the bacteriological laboratory, if possible within eight hours of collection.

A **chemical analysis** gives much useful information. It may indicate the probable source of the water. Thus waters from a depth usually have a high content of inorganic solids whereas upland surface waters are soft and contain comparatively little inorganic matter. Certain strata through which the water passes may give up characteristic salts detectable on chemical examination. Such an analysis also gives information as to the suitability of the water for human consumption. Thus an excessive amount of sulphates may cause some intestinal disturbance and may render the water too hard for domestic or trade purposes. Non-volatile solids should not ordinarily exceed 100 parts and total hardness 30 parts per 100,000. A water with less than 10 parts of hardness per 100,000 may be regarded as soft, with from 10 to 20 parts hard, with from 20 to 30 parts very hard, and with over 30 parts almost unusable. Hardness can, of course, be reduced by appropriate softening processes. The presence of poisonous or objectionable metals may be revealed as well as contamination with animal or vegetable organic matter. Thus animal contamination increases the amount of free and saline ammonia, albuminoid ammonia, chlorides, nitrites, nitrates and oxygen absorbed from permanganate. Vegetable contamination tends to raise the figures for albuminoid ammonia, oxygen absorbed from permanganate and, frequently, volatile solids. A rough guide with regard to the ammonias is that if the albuminoid figure reaches 0·008 part per 100,000, the free and saline must not exceed 0·005 part per 100,000. (In a pure upland surface water, however, the free and saline ammonia should never exceed 0·001 part.) The nitrates, inasmuch as they are the ultimate product of oxidisation of ammonia, should not exceed 0·1 part unless furnished by strata. If there is no other evidence of organic pollution this figure may be raised to 0·5 part, but such a figure is suggestive of past contamination. In such a case an opinion should be stated with reserve. Nitrites, which represent only partially oxidised ammonia—therefore recent animal pollution—should always condemn a water unless due to reduction of nitrates, *e.g.* by a salt of iron in greensand, iron pipes and cisterns, etc. The chlorine figure in rainwater does not exceed 0·5 part, but much higher amounts may be found in pure water from chalk or greensand strata or from reservoirs and wells near the coast. A figure of more than 0·1 part of oxygen absorbed from permanganate is suspicious, unless the

albuminoid ammonia figure is the only other figure showing an increase, when the pollution will almost certainly be of vegetable origin.

It is essential in reporting upon a water that all the figures of the analysis should be considered together.

The following analyses show the differences between two waters, one contaminated with animal organic matter and the other with vegetable :—

	A.	B.
Physical characters . .	good	slight brown colour
Reaction	neutral	faintly acid
Free and saline ammonia .	0·011	0·0005
Albuminoid ammonia . .	0·009	0·018
Total solids	31	13
Volatile solids	18	9
Non-volatile solids. . .	13	4
Total hardness	9	4
Permanent hardness . .	6	4
Temporary ,, . .	3	0
Chlorides	2·5	0·4
Nitrates	1·4	0·07
Nitrites	trace	nil
O_2 absorbed in two hours at 80° F.	0·13	0·21
Poisonous metals . . .	nil	nil
Sulphates	trace	nil
Phosphates	trace	nil

All in parts per 100,000.

A. is a shallow well water contaminated with sewage ; B is a typical peaty water.

Another sample of water gave the following figures of analysis :—

Physical characters .	excellent	
Free and saline ammonia	0·0021	part per 100,000
Albuminoid ammonia .	0·003	,, ,, ,,
Total solids . .	41	parts ,,
Volatile solids . .	9	
Non-volatile solids .	32	
Total hardness . .	28	
Permanent hardness .	3	
Temporary ,, .	25	
Chlorides . . .	3·1	
Nitrates . . .	0·29	part
Nitrites . . .	nil	
Poisonous metals .	nil	
Sulphates . . .	trace	
Phosphates .	trace	
O_2 absorbed in two hours at 80° F.	0·035	

A report on such a water would state that the somewhat large amounts of non-volatile solids and of total hardness indicated that the water came from a depth—in view of the high figure of temporary hardness probably from chalk. Both the ammonia figures are low as is the figure of oxygen absorbed from permanganate. The volatile solids form only a small proportion of the total solids. There is thus no evidence of recent animal or vegetable pollution. No poisonous metal was detected, and the trace of phosphate, significant as a rule of animal pollution, is in this case probably derived from the chalk itself and is therefore of no consequence. The amounts of nitrates and chlorides are fairly large but, in view of the low albuminoid ammonia figure, are almost certainly due to the chalk. Water from chalk may at times show figures of 0·4 to 0·5 and 3–5 parts per 100,000 for nitrates and chlorides respectively. This water is fit for drinking but on account of its high temporary hardness it should be submitted to some softening process.

Another analysis :—

Physical characters : slight brown colour, faintly acid in reaction

Free and saline ammonia	0·0038	part per 100,000
Albuminoid ammonia	0·015	,, ,, ,,
Total solids	14	parts ,, ,,
Volatile solids	11	,, ,, ,,
Non-volatile solids	3	,, ,, ,,
Total hardness	2	,, ,, ,,
Permanent hardness	2	,, ,, ,,
Temporary hardness	0	,, ,, ,,
Chlorides	2·1	,, ,, ,,
Nitrates	0·3	part ,, ,,
O_2 absorbed in two hours at 80° F.	0·21	,, ,, ,,
Poisonous metals	nil	,, ,, ,,
SO_4	nil	,, ,, ,,
P_2O_5	nil	,, ,, ,,

This water is soft and has a low figure of inorganic solids. It is probably a surface water, and as it is brownish in colour and slightly acid in reaction it comes most likely from an upland peaty area. The high figures of albuminoid ammonia and of oxygen absorbed confirm this view. The amounts of free and saline ammonia, chlorides and nitrates are, however, much greater than are usually found in a water of this nature and should be regarded as evidence of pollution with animal organic matter.

A chemical analysis of water is not always easy to interpret, and in any event reliance should not be placed on one examination alone. Repeated analyses should be made. A careful

local survey of the source should always be undertaken and arrangements made for bacteriological examinations to be carried out.

Bacteriological examination of water. The main object of the bacteriological examination of water is to find whether excretal pollution is present. A single examination is of value only when a water is so bad as to justify immediate condemnation. Several examinations with satisfactory results at different times of the year, and especially after heavy rainfall, are necessary before a water is declared free from dangerous pollution. Normally one does not look for specific pathogenic organisms, which are difficult to isolate. The usual practice is to estimate the number of bacteria of all kinds as well as the number of those of fæcal origin. A routine examination for indices of pollution includes agar counts at 20°–22° C. and at 37° C. and a coli-aerogenes count. Less frequently an examination is made for fæcal streptococci, *Clostridium welchii* and specific pathogenic organisms, especially *Bact. typhosum* and *Bact. paratyphosum.* Most bacteria developing on agar at 20°–22° C. and not at 37° C. are non-pathogenic to human beings, while those growing at 37° C. on agar are generally of soil, sewage or intestinal origin.

In the interpretation of results and the application of standards the colony count is of value if carried out on the same supply at regular intervals over long periods, when an increased count would call for explanation. Recently sunk wells and bores may give a misleading count for some time owing to contamination introduced in the work of sinking. Such contamination may persist for weeks or months in a new well, even though properly protected and tapping an unpolluted subsoil water. The ratio of the count at 22° C. to that at 37° C. is of use in helping to explain sudden fluctuations in the bacterial content of the water. The higher the ratio the more probable is it that the bacteria are clean soil and water saprophytes and therefore of small significance. The ratio may be low in summer and high in winter. In unpolluted water the ratio is usually 10 or more to 1 and in polluted water usually below 10, but no weight can be attached to a single observation. After chlorination the ratio has no significance and is usually very low.

The coli-aerogenes count or "presumptive coliform" test in lactose bile-salt medium is the index of pollution in general use in this country. By the use of probability tables it enables the approximate number of coliform organisms present in 100 ml. of the sample to be estimated. The "presumptive coliform" reaction may be due to typical *Bact. coli* or to atypical organisms of the aerogenes-cloacae-intermediate group. The typical habitat of the former is the animal intestine and they

are therefore of more significance as indicators of excremental pollution than the latter.

This subject is discussed in detail in the Ministry of Health Report No. 71 (revised edition), 1939, "The Bacteriological Examination of Water Supplies," which contains much useful information regarding sampling, apparatus and bacteriological technique. It also classifies waters as follows :—

PIPED SUPPLIES

		Presumptive Coliform Count per 100 ml.
Class 1.	Highly satisfactory .	less than 1
,, 2.	Satisfactory . .	1–2
,, 3.	Suspicious . . .	3–10.
,, 4.	Unsatisfactory . .	greater than 10

Throughout the year 50 per cent. of samples should fall into Class 1 ; 80 per cent. should not fall below Class 2 ; and the remainder should not fall below Class 3.

In chlorinated piped supplies the water should come into Class 1, and a fall to Class 2 should occasion misgivings as to the adequacy of the chlorination process.

With deep well, or other very pure waters, which normally fall into Class I, a drop to Class 2 should not be neglected, and an attempt should be made to detect any possible source of pollution.

Some relaxation from these standards is permitted in samples drawn on consumers' premises, but even here the presence of fæcal coli should be regarded as a danger signal.

In the case of private supplies in rural districts, it may be difficult to reach the standard of Class 3, but after proper attention has been given to the construction of the well and the removal of obvious sources of contamination it should be possible to reduce the coliform count of a shallow well water to below 25 per 100 ml.

Emphasis is laid upon the importance of topographical examination, and a water should never be regarded as safe, whatever the results of bacteriological examination, if it is exposed to known sources of potentially dangerous pollution.

More detailed information will be found in the Report mentioned above and the reader is also referred to "The Examination of Waters and Water Supplies," Suckling, J. & A. Churchill, 1943, which deals in a comprehensive manner with all matters connected with water supplies.

SECTION VIII

REMOVAL AND TREATMENT OF WASTE MATTERS

THE REMOVAL AND TREATMENT OF SEWAGE

SEWAGE consists of solid and liquid human excreta, waste water from dwelling-houses, trade wastes and frequently surface or rainwater and road washings.

An adult passes on an average about 4–4½ oz. of solid fæces (not water-free) and 50 oz. of urine per day. In a mixed community these amounts may be taken as 2½ oz. and 40 oz. respectively. Where rainwater is dealt with separately the remaining liquid portion of the sewage approximates to the water supply, though some of this is lost and does not find its way to sewers or cesspools. The strength of a sewage depends largely on the water supply reckoned as so many gallons per head per day. It is obvious that a community with a water supply of only 5 gallons per head per day will yield a sewage of much greater concentration than a community with a supply of 30 gallons. The quantity of sewage to be dealt with largely determines the method of disposal. In districts where there is no public water supply piped to the houses, conservancy methods prevail; where there is such a supply, proper sewerage schemes must be undertaken.

Disposal of excreta by conservancy methods

These methods imply the retention of human excreta in or near the dwelling, with removal as frequently as possible. Some means must be adopted in addition for dealing with waste waters.

Privies are closets in which the excreta are deposited in a fixed receptacle of such size that a weekly removal of the contents is necessary. Such conveniences are placed usually in the back yard of a dwelling-house. In a privy-midden the closet seat is placed above a bricked-in space, which serves as a receptacle for excreta and house refuse. Privies are insanitary, and their construction in relation to new buildings is not now permitted.

Earth-closets are the most suitable form of conservancy apparatus for use when there is land available on which to dispose of the contents. Earth acts in the first instance as a deodoriser, and when well mixed with the fæces ensures complete disintegration in a short time. The receptacle for an earth-closet should be of stout galvanised iron of not more than

2 cubic feet capacity. The earth used should, if possible, be light loam well dried and sifted to ¼-inch mesh. At least half a pound of earth is required by each user. Modern earth-closets are fitted with a simple apparatus for the application of earth. Earth-closets may be used with success in small schools in rural districts.

Pail-closets are closets with movable receptacles. Metal pails or tarred wooden tubs of a capacity not exceeding 2 cubic feet receive the excreta, and fine household ashes or sawdust may be used as a covering. The disposal of the contents of the pails is simplified in some circumstances if absorbent material such as sawdust is placed in the containers prior to use.

In all these systems waste waters must be excluded from the closets. The drier the contents the more readily is offence minimised, and the more easily is subsequent disposal effected.

Disposal of receptacle contents. (*a*) *Trenching in land.* A suitable area of loamy soil should be selected, the excreta placed in trenches about 9 inches deep, and covered with 3 or 4 inches of earth. Such a trench, 8 feet long and 7 inches wide, will take one day's excreta of 100 persons. Under suitable conditions the same patch of ground may be used over and over again at intervals of a few months.

(*b*) *Incineration.* This method is used in the army when disposal by other means is not practicable. One destructor, if properly designed, is capable of dealing with the excreta of 500 men per day, together with the dry camp refuse. The mixing of fæces with dry refuse, however, is deprecated. (*J. Roy. Army Med. Corps*, May, 1942.)

Conservancy systems are practised usually in small country villages, but in some large cities privies and pail-closets still remain. For the removal of the contents on a large scale special carts must be used, and as frequent collections as possible must be made. Wherever a proper water supply and sewers are available, conservancy apparatus should be converted to water carriage. Local authorities have power to require such conversion and must bear part of the cost (see p. 531). In addition to causing a high incidence of typhoid fever and other diarrhœal diseases, conservancy systems have actually been proved to be more costly in the long run than the substitution of water carriage. Privies should invariably be abolished; pail-closets are perhaps best when communal arrangements permit of a daily removal of contents, otherwise earth-closets, if carefully attended to, will give the most satisfactory results. (For Model Bylaws, see pp. 538 and 540.)

Disposal of waste waters under conservancy systems. In unsewered districts arrangements must be made for the proper

removal of waste waters even though no water-closets are provided. In isolated country districts the usual practice is to distribute these wastes on garden land, each cottage disposing of its own waste. A more satisfactory method is to run the water into a series of agricultural drains, placed at a depth of about 6 inches under the surface of a plot of grass, or at a slightly greater depth in a tilled portion of the garden. In any building in which a piped water supply is available a complete system of drainage by water carriage may be provided, but a suitable outfall for the system is necessary, and this must also be provided, generally on the same site. The outfall may take the form of a retainer or tank to be emptied by mechanical means as and when required, *e.g.* a cesspool, or it may be a complete unit for the purification and subsequent disposal of the sewage (see p. 501).

Cesspools. All cesspools should be watertight. They are usually constructed in 9-inch brickwork rendered on the inside with cement and surrounded at the sides and bottom with puddled clay from 6 to 9 inches in thickness, but a simpler and equally suitable method involves the use of reinforced concrete pipes such as are used for main sewers. Two or more such pipes set on end, the bottom being made watertight with concrete, form an excellent cesspool. A cesspool should be covered, provided with means of access and effectively ventilated. House drains are connected to a cesspool in exactly the same way as to a sewer, an intercepting trap being provided to prevent ventilation of the cesspool through the drain. A cesspool can be made to receive all liquid wastes, but in order to reduce the volume of sewage to a minimum, rainwater should be treated separately and taken into a "soakaway" or otherwise disposed of on the land.

An impervious cesspool is merely a container of sewage, and frequent emptying is necessary. For this purpose a special form of pump or sewage lift is generally employed, the sewage being removed in watertight carts and disposed of on land. A much better method of emptying cesspools is by means of the vacuum gully-emptier now used by most progressive local authorities. This apparatus consists of a closed cylinder of about 1,000 gallons capacity mounted on a motor chassis, and a 6-inch flexible suction pipe sufficient in length to pass from the cylinder to the bottom of the cesspool. The motor is utilised to create a vacuum of approximately 20 inches in the cylinder, after which, when a valve is opened on the suction pipe, the contents of the cesspool are transferred to the cylinder by the pressure of the atmosphere. There is no agitation or exposure of the sewage, and the emptying of cesspools by this means can be carried out at any time of the day without causing the least nuisance. Final disposal of the sewage is by broad

irrigation either on ploughed land or on land specially prepared and set aside for the purpose.

The position for a cesspool should be selected with great care. It should never be less than 50 feet from a dwelling or 100 feet from a well. Should the local water supply be derived from the subsoil, *e.g.* from a shallow well, the cesspool should be so situated that the normal flow of subsoil water in its vicinity is away from and not toward the well. Cesspools should not be tolerated in towns. Unless they are very well constructed under careful supervision they rarely remain sound, and a leaking cesspool may contaminate a drinking water supply.

The chemical closet. This is a type of container apparatus in which the excreta is received into a disinfectant solution which may also have a liquefying action on the fæcal matter. There are two kinds of chemical closet—in one an alkaline emulsion of coal-tar or similar product is used for disinfection and deodorisation, and in the other a strong solution of caustic soda is the principal chemical employed. While the liquid part of the contents is rendered sterile, the fæcal matter is not always broken up and may therefore remain infective. The contents are disposed of by burial or, if liquefied, may be discharged into a suitably placed soakaway approved by the local authority. Whatever method of disposal is used it should be remembered that there is risk of incomplete disinfection, and therefore care should be taken to ensure that there is no contamination of water supplies or other danger to health. This apparatus has come largely into use for small isolated houses. In portable form it is particularly suitable for trains, boats, aircraft and emergency premises, *e.g.* air-raid shelters. The chemical closet may be regarded as fly-proof.

The bored-hole latrine is now extensively used in the tropics and is coming into use in European countries for camps, etc. It consists of a round hole, 16 inches in diameter and about 18 feet deep, bored into the earth with an auger. A concrete slab, on which the user of the latrine can squat, is placed over the mouth of the hole, with a rectangular opening 4 to 5¾ inches wide and 14 inches long. The slab should be 2½ inches thick at the edges, sloping on the upper surface to 2 inches thick at the opening in the centre. For European use an ordinary latrine seat fitted to a suitable riser is fixed over the boring, the top 2 feet of which are lined with concrete to give the necessary support. A simple superstructure is erected over the latrine. Bored-hole latrines usually reach the subsoil water, which helps to dissolve the excreta, and may be used for long periods without requiring any attention. If the site is carefully selected, there appears to be little risk of contaminating water supplies. (*J. Inf. Dis.*, September-October, 1937, pp. 148–183; November-December, 1937, pp. 264–288,

Caldwell; *Bull. of Hyg.*, August, 1938, pp. 591–599, "The Bored-Hole Latrine," Carter.)

Water carriage system

In this system all liquid wastes and fæcal matter are removed by gravity through pipes to disposal works. For administrative purposes the system is divided into two main sections, viz. drains and sewers. Drains are pipes or channels used for the drainage of one building and of any yard and buildings appurtenant thereto, and within the same curtilage. (See p. 527 as to the meaning of public sewers.) A drain is private property, belonging to the owner of the premises drained. A public sewer is vested in the local authority.

Drainage systems. The materials in common use for drain-pipes are glazed stoneware and cast iron. Stoneware is a mixture of clay, flint, and sand. For the reason that the glazing is obtained by the action of salt volatilised during the process of burning, the term "salt-glazed stoneware" is usually applied to pipes made of this material.

The term "stoneware" is frequently confused with that of "earthenware," but the two are quite different. Earthenware is plain burnt clay, which is much softer than stoneware. Pipes of this material are unglazed and unjointed, they are used for subsoil drainage only, and for this reason are often described as "agricultural" pipes. Stoneware pipes are made in lengths of from 2 to 3 feet, according to their diameters. They are jointed by portland cement with a small admixture of clean, washed sand, a gasket of hemp or yarn being first placed in the socket to ensure a true invert. It is most important that any cement finding access to the interior of the pipes during the process of jointing should be properly cleaned out. Stoneware pipes can withstand great compressional stress, but as their tensile strength is very low they must always be supported upon a concrete foundation to prevent movement and consequent fracture. They are usually laid upon a bed of concrete 6 inches in thickness and extending on each side to a distance of 6 inches beyond the exterior of the pipes. In addition the concrete is "haunched" up at the sides to one-half the diameter of the pipes after they are laid and the joints are set. In unstable ground the concrete should be reinforced with steel rods. For many reasons it is desirable that drains should be placed outside and not under or within a building, but this is not always possible. Stoneware drain pipes are used as a rule only for drains in external positions, but where they are laid under or within a building they must be surrounded by concrete 6 inches thick at all points.

Cast-iron drain pipes are 9 feet in length and are protected against corrosion by a coating of bituminous material which is

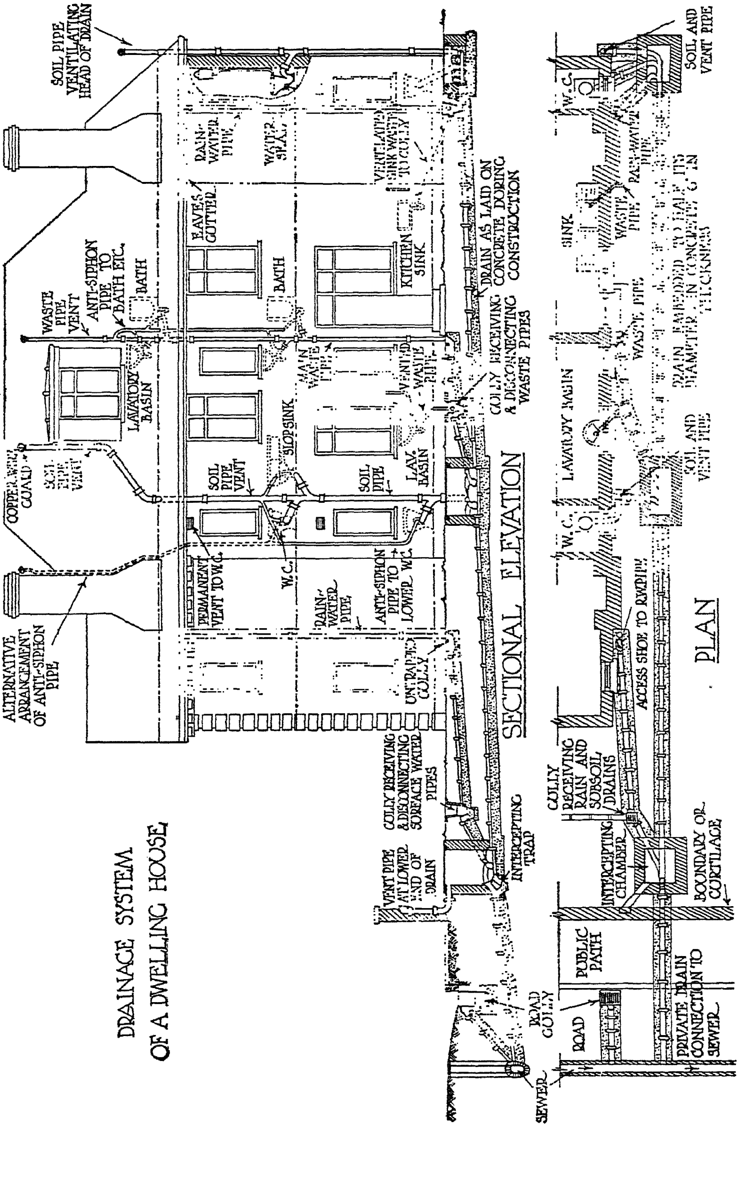

DRAINAGE SYSTEM
OF A DWELLING HOUSE
SECTIONAL ELEVATION
PLAN
SOIL PIPE VENTILATING HEAD OF DRAIN
WASTE PIPE VENT
ANTI-SIPHON PIPE TO BATH ETC.
BATH
LAVATORY BASIN
COPPER WIRE GUARD
SOIL PIPE VENT
ALTERNATIVE ARRANGEMENT OF ANTI-SIPHON PIPE
EAVES GUTTER
RAIN-WATER PIPE
WASTE PIPE
KITCHEN SINK
MAIN WASTE PIPE
VENTED WASTE PIPE
SLOPSINK
W.C.
PERMANENT VENT TO W.C.
SOIL PIPE
LAV. BASIN
ANTI-SIPHON PIPE TO LOWER W.C.
UNTRAPPED GULLY
DRAIN AS LAID ON CONCRETE DURING CONSTRUCTION
GULLY RECEIVING & DISCONNECTING WASTE PIPES
GULLY RECEIVING & DISCONNECTING SURFACE WATER PIPES
VENT PIPE AT LOWER END OF DRAIN
INTERCEPTING TRAP
ROAD GULLY
SEWER
SOIL AND VENT PIPE
SINK
LAVATORY BASIN
ACCESS SHOE TO RWPIPE
GULLY RECEIVING RAIN AND SUBSOIL DRAINS
INTERCEPTING CHAMBER
BOUNDARY OF CURTILAGE
PUBLIC PATH
ROAD
PRIVATE DRAIN CONNECTION TO SEWER

Fig. 11.

applied by dipping them into the liquid material at high temperature immediately they are cast. A pipe of 4-inch diameter weighs 157 lb. The joints are made by filling with molten lead, a gasket of hemp or yarn being first inserted as in stoneware pipes. The lead has to be thoroughly "caulked" home to counteract the effect of contraction of the metal on cooling. Owing to the greater strength of cast-iron pipes with caulked joints, and to the fact that they can be supported upon cantilevers or piers, and also that means of access can be obtained wherever necessary through plates bolted down upon junctions or upon the pipes themselves, cast-iron pipes are particularly suitable for drains within or under buildings and are now almost universally adopted for these positions.

A drain should be watertight to ground level and so designed and constructed as to be capable of conveying sewage automatically, constantly and without causing the slightest inconvenience or risk of nuisance; in a word, it should be self-cleansing. To meet these requirements a drain must be (*a*) as straight as possible between points of access, (*b*) of smooth interior, and (*c*) laid to a true invert so that friction is reduced to a minimum. The diameter and gradient should be such as to ensure a suitable velocity and depth of flow so that solids in the sewage may be "water-borne" during the whole journey through the drain. It is found that a good working velocity is about 2·5 feet per second, and for this the following gradients are suitable: 1 in 40 for 4-inch; 1 in 50 for 5-inch; and 1 in 60 for 6-inch drains. A drain 4 inches in diameter is sufficient for any ordinary dwelling house; a larger diameter should be adopted only in cases in which the rainwater likely to fall during a storm upon the whole site occupied by the building would be greater than such a pipe could convey. All points in a drainage system at which stoppage is likely to occur, such as junctions and changes of direction, should be provided with means of access in the form of access chambers or manholes. These and other details of drainage construction dealt with in this chapter are illustrated in Fig. 11.

The ventilation of a drainage system is a most important feature of its construction. Ventilation is necessary to prevent the accumulation of foul air in the drain as well as to prevent the breaking of water seals in the traps by siphonage or air pressure. Adequate means of ventilation at the highest and lowest ends is a minimum requirement of most drainage by-laws. The temperature of the air inside a drain is usually higher than that of the atmosphere and the direction of air currents is consequently from the lowest to the highest point. It is a common practice to take advantage of this by providing a vent pipe terminating at or near ground level at the lowest end (usually connected to the intercepting chamber) to act as an

inlet, and another at the highest end carried up to terminate well above and away from all openings into the building, so as to prevent the possibility of nuisance from the emission of foul air. As an alternative arrangement both pipes are carried up to positions affording safe outlets for foul air. These pipes may not be less than 3 inches in diameter. Soil pipes are always ventilators to the drain, and if suitably situated may be the only means of ventilation provided. All drain openings, other than those provided for ventilating the system, and the outlets of all sanitary fittings should be effectively trapped.

A trap, in its simplest form, is a pipe bent on itself in such a way as to retain a certain amount of water in the bend. That portion of water which prevents the passage of gases from one side of the trap to the other is known as the 'seal."

The requirements of a trap are :—

1. Made of hard, smooth and impermeable material.
2. Self-cleansing.
3. Simple in construction.
4. No movable part.
5. No angles or corners.
6. A water seal of about 2 inches.

A simple form of trap is illustrated in Fig. 12. By reason of its shape the trap illustrated is known as an " S " trap. When the outlet is horizontal instead of vertical it is known as a " P " trap. A metal cap or plug is provided for cleaning purposes at the bottom of the trap as shown. The inner surface of this should conform to the curve of the trap so that it cannot catch and retain solid matter and become a cause of stoppage. As stated above the effective part of a trap is the "water-seal" (A B, Fig. 12). If by any means the water forming the seal is removed the seal is broken and the trap rendered useless. There are several ways in which this may occur, viz. siphonage, air compression in the system, momentum, and evaporation. Both siphonage and air compression may be prevented by adequate ventilation of the system. Where two or more traps discharge into a common pipe, as in the case of several water-closets discharging into one soil pipe, the flushing of one is liable to unseal the traps of those below it. This is occasioned by the fact that the passage of water down the main pipe has an aspirating effect upon the air in the lower branches, reducing the atmospheric pressure in these and causing the seal to be siphoned out. In the case of vertical pipes in high buildings, a discharge down the main pipe may cause momentary compression of the air in the lower branches and the seals of traps con-

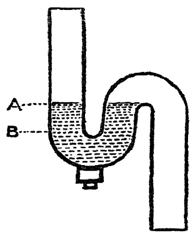


FIG. 12.

nected to these may be "blown" out. In order to preserve equilibrium of atmospheric pressure throughout a system and prevent both siphonage and air compression, a pipe, sometimes known as an anti-siphon pipe, is joined to the outlet of each trap and either connected to the soil pipe at a point above the highest fitting, or carried up separately as a vent pipe. The diameter of an anti-siphon pipe is usually equal to one-half that of the main soil pipe or waste pipe to which it is connected. The trap of a single fitting needs to be ventilated if the pipe to which it is connected exceeds 6 feet in length.

The breaking of a water seal by momentum is rare and occurs only in special circumstances. It is prevented by the use of a trap known as an anti-D. trap, having a square and horizontal outlet. This has the effect of retarding the flow sufficiently to preserve the seal intact.

Unsealing by evaporation can occur when traps are unused for long periods. Periodic flushing is the obvious remedy, but if this is not possible a film of glycerine, added so as to reach both surfaces of the water seal, is an effective remedy.

In addition to the traps on all drain openings and sanitary fittings it has been the practice for many years to place a trap, called an intercepting trap, as near as practicable to the outlet of the drain itself before it joins the sewer, to prevent the passage of air from the sewer into the drain. The intercepting trap has a vertical (cascade) inlet but a sloping outlet which finishes about 2 inches below the level of the inlet. The seal is usually 3 inches in depth. A raking arm closed by a tight-fitting stopper is provided as a means of access to the drain below the trap. The use of this trap has been the subject of much controversy and was investigated by a Departmental Committee. (Report of the Departmental Committee on Intercepting Traps and House Drains, 1912.) The purpose of the trap, as stated above, is to prevent the passage of air from the sewer into the drain. An additional advantage sometimes claimed for it is that it prevents the passage of rats, but against this must be placed the fact that in most districts special provision is made against rats in the form of a flap valve fitted to the drain outlet in the sewer wall. The disadvantages of the trap are that it retains a certain amount of sewage solids and increases the liability to stoppage. Further, it prevents the ventilation of sewers through the ventilating system of the drain and renders the effective ventilation of sewers impossible. By the abolition of the intercepting trap the problem of sewer ventilation (the importance of which is growing with the ever-increasing use of petrol and other volatile oils) would be solved or greatly simplified (see p. 528). The necessity for a separate ventilating pipe at the lowest end of every drain would be obviated, and

sewer openings at road level would normally act as fresh-air inlets. Since the intercepting trap is already installed in most towns, its omission is practicable only in connection with the development of new estates.

Sanitary fittings intended for the reception of excremental wastes are known as soil fittings, and the pipe to which they are connected at points above ground level is known as the soil pipe. This is simply a continuation of the drain itself, it is never less than 3 inches in diameter and, since it always terminates in a position providing a safe outlet for foul air, it is a valuable ventilator to the main drain. Soil pipes may be constructed of lead or copper, but usually they are constructed of heavy cast iron with caulked lead joints. They should be fixed about $1\frac{1}{2}$ inches clear of the wall and protected at the top by a wire cage.

Lavatory and scullery fittings (baths, lavatory basins, bidets, sinks, etc.) are not generally treated as described above. The pipe to which they are connected is known as a waste pipe. It is of small diameter, usually 2 inches, and is made to discharge in the open above the water seal of a trapped gully. A waste pipe is thus " disconnected " from the drain and does not ventilate it.

The division of sanitary fittings into two classes—soil fittings and waste fittings—and the disconnection of waste pipes from soil pipes and drains are not now considered necessary. A modern system of drainage from which this form of disconnection is omitted is known as the " one pipe " system, the outlets of all fittings discharging into a common pipe directly connected to the drain, *i.e.* without the intervention of a trap : this system is permissible under modern bylaws. Its adoption is becoming general in large buildings such as hotels and blocks of flats. In small buildings of the " domestic " type, such as villas and cottages, in which sanitary fittings are liable to be scattered, this system is less advantageous, In such cases the older system is frequently more convenient and not more costly to install.

Rainwater pipes, or " downspouts " as they are sometimes called, are kept separate from all other pipes and made to discharge over or into trapped gullies. Although it is a common practice in some districts, the discharge of wastes from ablution fittings into these pipes is to be deprecated. Rainwater pipes are usually open-jointed, they are larger than is necessary for waste pipes, and must of necessity terminate below the roof, in many cases under or near windows. Even where the " one-pipe " system is adopted, pipes for the conveyance of rainwater must be disconnected from the drain in the manner described above.

Subsoil drains are entirely different from sewage drains, their

object being to drain the subsoil and control the level of the subsoil water. They are constructed so that water may pass freely into them from the surrounding earth and find its way to a natural outfall, or, if this is not available, to a sewerage system. When drainage of this kind is required it is usually advisable to construct a system in the form of one or more main pipe lines to which branches are connected at intervals of about 4 feet. They are constructed of porous pipes with open joints laid in trenches and surrounded by coarse brick rubble or similar material, the joints being covered with curved tiles at the top to prevent stoppage. They should be laid not less than 9 inches below the level to which it is safe to allow the subsoil water to rise. Subsoil drains must be freely ventilated and before being connected to a sewage drain must be effectively trapped.

Sanitary fittings

The heavier types of sanitary fitting, *e.g.* those intended for use in schools, factories, and the like, are made of fire-clay, but fittings for use in residential buildings are made of a much finer and lighter material known as vitreous china. Sanitary fittings should be so designed that they are either self-cleansing in use, or that parts likely to become foul are accessible for purposes of cleansing.

In England the water available for flushing a sanitary fitting is usually limited to 2 gallons, discharged from a flushing cistern by siphonic action. Fittings intended for the reception of excremental wastes, *e.g.* water-closets, urinals, and slop sinks, are constructed for connection with a flushing apparatus of this kind, and the degree to which these fittings are self-cleansing depends upon their shape and form as much as upon the amount and force of the flushing water.

A closet basin should have a flushing rim so arranged that the whole of the interior surface of the fitting is scoured at each flush, the bulk of the water being discharged in a column from the front of the rim directly into the trap in the direction of the outgo. The posterior wall of the basin should be vertical and should dip into the water to a depth of not less than $1\frac{3}{4}$ inches to form a water seal. The trap should be of small water content, but should have a large water area on the inlet side. The basin and trap are usually made in one piece and mounted upon a solid base for attachment to the floor. The outlet should be above floor level for ready and sound connection to a soil pipe or drain. A closet basin constructed on these lines is known as a " pedestal washdown," and is the simplest and most common form of basin in use in this country.

It will be observed that the minimum seal in the trap of the closet above described is $1\frac{3}{4}$ inches. This is the maximum depth of seal which is practicable in a fitting dependent for its

self-cleansing properties upon a flush limited to 2 gallons of water. A deeper seal is possible and other advantages are obtainable by the use of what is known as a siphonic closet; an excellent fitting in which the pressure of the atmosphere is utilised to assist in the cleansing of the basin. In its simplest form the siphonic closet consists of a basin of large water content and a water seal 3 inches in depth. The outlet of the trap is first enlarged and then suddenly contracted to 3 inches in diameter. This has the effect of causing water discharged through the basin to mix with and carry away the air in the outlet, thereby setting up siphonic action by which the contents of the basin are removed. This type of fitting is highly efficient; but the flushing pipe should not be less than $1\frac{1}{2}$ inches in diameter. Another form of siphonic closet is provided with two traps, one in the basin itself and another on the outlet at a lower level. The flush is divided into two streams; one passing to the flushing rim in the ordinary way, the other being directed into the vertical pipe between the two traps. When the flushing cistern is operated this stream of water in its passage to the lower trap carries some air with it and sets up siphonic action. The contents of the basin are thus removed by the pressure of the atmosphere effectively, completely, without noise, and with very little preliminary agitation.

The best type of urinal is unquestionably the stall, but many of the designs in common use are far from being self-cleansing. The stall should be shallow from back to front with a flat back sloping forward into a half-round channel. In urinals for public use this channel should drain the floor, its outlet being the only drain necessary in such a case. In private premises, however, and on upper floors in particular, the channel has necessarily to be placed above floor level, and a step-up has to be formed. This step should not overhang the channel as the resulting angle is invisible, not easily accessible, and is generally a source of nuisance.

Slop sinks are used principally in institutions. They should be constructed upon lines similar to water-closets except that the posterior wall need not be vertical. A flushing cistern is necessary in addition to the hot and cold water supplies usually provided.

A fitting that has come very largely into use in recent years is the bidet. This is really a small sitz bath provided with hot and cold water supplies and a plug at the outlet. It is intended to be filled with water in the same way as a bath. In domestic sanitary engineering the bidet is classed as an ablution fitting, and, where main waste pipes are disconnected from drains, the outlet is connected to the waste pipe and not directly to the soil pipe or drain.

Two points only call for special attention in the bath, lavatory

basin, and sink; these are the overflow and the waste outlet. It is very important that the overflows of these fittings, since they receive mainly soap and similar curd and are not adequately flushed, should be readily accessible for purposes of cleansing. The open weir type of overflow, protected by a hinged grating, is the best arrangement. Outlets to waste pipes should be of large diameter; this not only ensures rapid emptying but increases the flushing force of the discharge from these fittings. The waste pipes themselves should not discharge over the grid of a gully (as was a common practice for many years), but they should be made to pass through or below the grid, and discharge in a downward direction immediately above the water seal in the trap. In this way the gully, which is usually one of the most insanitary fittings in any drainage system, is made self-cleansing, and the valuable flushing force of discharges from such fittings as baths, instead of being dissipated, is fully utilised to flush the system and keep it clean.

Drain testing

The means by which the soundness and efficiency of a drainage system are tested are regarded as falling under two headings, *i.e.* pressure and non-pressure tests. Of the pressure tests that by which the drain is subjected to a test by water under pressure due to its own head is the most searching, and may be severe. The use of this test is restricted to new drains constructed under bylaws in which a test by water is prescribed. In the case of existing drains the duty of the officers of a local authority is limited to ascertaining whether the drain is sound in the sense that it is gas-tight rather than water-tight (see p. 531).

A mild form of pressure test is that applied by smoke or air in which the pressure exerted is limited to the head of water in an ordinary gully or closet trap, and this may be regarded as a perfectly fair test in all circumstances.

The most common non-pressure test is known as the chemical or scent test. This consists in the application of a strongly smelling substance to the drain, any escape of which is indicative of defect. The application of the chemical test is made very simple by the use of testers specially prepared for the purpose. These consist of small metal containers filled with calcium phosphide and sealed with cement. One or two of these are washed into the drain through a trap situated as far as possible from the lowest end. The water used to carry the testers through the trap dissolves the cement and liberates the chemical, and this results in the evolution of phosphoretted hydrogen, a powerful and penetrating gas of distinctive odour, in sufficient quantity to fill the drain. Any escape or " return " of the gas is easily detected, and is *prima facie* evidence of defect. In the absence of special apparatus the chemical test may be applied by washing oil of

peppermint or calcium carbide into the drain, but special care must be taken to avoid escape of the odour of the testing substance during the process of application. The point chosen for the application of the test should be outside and as remote as possible from the building. A good practice is to pour the substance down a ventilating pipe where this is possible and wash it through with hot water; the pipe should then be closed. After the application of a chemical test the drain should be under observation for at least half an hour. A disadvantage of the chemical test is that, although it may indicate a defect, it does not necessarily locate it.

The smoke test is usually applied by means of a machine of which several types are in common use. The smoke is obtained by the combustion of oily waste or other suitable material in a closed chamber from which it is forced into the drain by means of a fan or an air-bellows. The smoke is applied through a stopper placed in the lowest part of the drain, usually in the intercepting chamber; from here it is forced through the drain and ultimately escapes from the open soil or vent pipes, which pipes are then closed. Continued pumping produces a slight pressure in the drain which depresses the water in a gauge on the machine to the same extent as it alters the position of the water seals in the various traps. Escape of the smoke in any quantity is indicated by the fall of water in the gauge and is easily detected. In applying the test great care must be taken not to force smoke through the traps as this would render the test abortive. A simpler means of testing by smoke is by the use of a smoke-rocket. No pressure is obtainable however, and great difficulty may be experienced in filling the whole of the drain. This test is useful for demonstrating that a drain is clear or for tracing connections rather than as a test for condition.

A test similar in character to the smoke test is the pneumatic or air test. All untrapped openings in the drain are stopped, and air is pumped into the system until a pressure equal to the head of water in the trap is reached. The result is observed in a water-sealed U-tube. The usefulness of this test is confined to soil and waste pipes above ground level.

As already stated the water test is used on new drainage systems only. The drain is closed at the lowest end by means of an expanding rubber stopper and filled with water to ground level—usually to the top of a suitably placed gully trap. In order to ensure the exclusion of all air the traps or branch drains must be either emptied or ventilated during the process of filling. Each branch or section of a system should be tested separately. The drain should remain under test for twenty to thirty minutes. If leakage is disclosed, the amount of the leakage in any given time may be measured with accuracy. It

should be noted that the water test is necessarily one of varying severity. As the pressure increases with the depth of the drain, the test is more severe on the lower portions of a drain than on those portions near the surface of the ground.

Modern sewers are made to convey all household effluents, liquid trade wastes, water used for municipal purposes, and surface or rain water. They vary in diameter from 6 inches to as much as 10 feet. Small sewers are constructed of glazed stoneware pipes laid and joined in the same manner as house drains (see p. 476). Sewers from 1 to 4 feet in diameter are constructed chiefly in reinforced or spun concrete pipes with socket joints. Where excessive vibration has to be resisted, or where sewers are laid through waterlogged or unstable earth, cast-iron pipes suitably coated against corrosion are used; similarly, where some amount of flexibility is required to meet local conditions, pipes of mild steel jointed by deep sockets filled with bituminous material are adopted with marked success. Large main sewers are constructed of brick, set in cement and sand mortar. Sewers up to approximately 2 feet in diameter are circular in section. Above that size they are usually egg-shaped for the reason that this section preserves a greater depth and velocity of flow, and a proportionately smaller wetted perimeter, when the volume of sewage is small than is the case with a circular section of equal area. Sewers, like drains, should be designed to be as far as possible self-cleansing. The velocity of flow is influenced by several factors, the chief of which are inclination or gradient of the sewer, the volume of the flow, and the frictional area or wetted perimeter. The volume of flow, and consequently the wetted perimeter, vary constantly. Domestic drainage is greater at certain periods of the day than at others, and the same is true of trade and municipal sewage. Velocity of flow is influenced also by the density of the sewage and the nature and amount of suspended matter it contains. The only constant factor, therefore, is the gradient to which the sewer is laid, and as far as local circumstances will permit this is arranged to give a velocity of from 2 to 3 feet per second. It is very important that "ponding" should not occur in sewers as there is danger to workmen and even risk of explosion from gases set free by sudden disturbance of any septic sewage in the confined space of a sewer. In places where a suitable velocity of flow cannot be maintained sewers should be flushed by means of automatic flushing tanks which discharge into the sewers through pipes of large diameter.

In low-lying districts where a sufficient gradient cannot be obtained and where difficulties arising from unequal levels have to be overcome, it is necessary to lift the sewage at intervals

along its course to the outfall. For this purpose an automatic apparatus such as Shone's ejector is used. This apparatus consists of a closed tank into which the sewage gravitates. The motive force is compressed air supplied from a central station. When the tank is full a valve controlling the compressed air is opened by means of a float. The pressure of the air thus admitted into the tank is sufficient to lift the sewage through a vertical pipe into a sewer at a higher level. The pipe through which the sewage is discharged is connected to the bottom of the tank so that solids gravitating to this point are discharged first and are followed by the liquid portion of the sewage.

The exclusion of rainwater from ordinary sewage and the provision of a dual system of sewers are an advantage where the purification of sewage presents special difficulties, or where the surface water can be disposed of with ease and safety, *e.g.* into a river or the sea. In many places, however, owing to the polluted condition of street washings and the difficulty of ensuring the passage of household water into the proper drain opening, the system yields less favourable results than were anticipated. In order to be successful the roofs only of private premises should drain into the surface-water system by spouts used for no other purpose, and the gullies receiving these spouts should be closed. If yards or any paved surfaces in the vicinity of buildings are connected to the surface-water system, pollution will occur through the deposition of washing water and other household wastes into drain openings intended only for draining these surfaces. The surface-water system may also be polluted by the indiscriminate connection of baths, lavatory basins, sinks, etc., to rainwater pipes or spouts, and considerable pollution of streams may occur from this cause before the origin of the trouble can be traced.

The ventilation of sewers has always presented difficulties, and the common use of petroleum spirit and other volatile oils renders the problem one of increasing importance (see p. 528). Adequate ventilation is necessary to prevent air compression in times of storm, as well as to preserve the purity of air in the sewers. It must also be remembered that the fewer the openings provided the greater and the more objectionable will be the emanations from them. Since the drains of private premises are generally provided with intercepting traps, the chief object of which is to prevent the ventilation of the sewers through the drains, the only practicable means of ventilation is by shafts taken through the crown of the sewer and left open at road level, or by vent pipes taken up to points above the windows of adjacent buildings. There are many objections to each of these expedients, and many complaints to public health departments relate to them. Tall factory chimneys are sometimes utilised

to aspirate air from sewers. The vent pipe from the sewer is made to terminate in the chimney, thereby taking advantage of the ascending current of warm air. Another device is to utilise hollow gas-lamp posts as ventilating shafts ; the gas-flame tends to create an up-current and destroy the effluvia.

Several physical factors influence the ventilation of sewers. In winter, sewer air is warmer than the outside air ; in summer, it is cooler. Sewer air is also moister, therefore lighter, and consequently tends to rise. In this way a continuous diffusion of air takes place between the sewer and the outside, and the ventilating shafts are the means by which this interchange can take place continuously. Variations in the volume of sewage expel air or cause it to be drawn in. Other factors concerned in sewer ventilation are sudden changes in barometric pressure and the aspirating effect of the wind blowing across the top of ventilating shafts.

In newly developed residential districts in which sewers are constructed as soundly and properly as the drains, it is becoming more and more the practice to omit the intercepting trap from private drains, and for purposes of ventilation, as for the conveyance of sewage, to treat the drainage and sewerage systems as one unit. In this way every house drain plays its part in ventilating the whole system and the problem of ventilating sewers is solved. A properly constructed sewer in a road having fifty houses on each side has thus at least 100 (and probably more) vent pipes directly connected to it. These act both as aspirators and as air inlets, the circulation of air is necessarily more free than when interceptors are used, and emanations from the pipes are not more foul than those from intercepted drains. In systems of this kind where openings are provided to manholes at ground level they are frequently found to act as air inlets.

The importance of sound construction of sewers and of the maintenance of sewers and drains in perfect condition has received practical emphasis on many occasions from the ease with which water-borne diseases such as typhoid fever may occur and spread as the result of defective drainage (see Ministry of Health Report, No. 69, 1933). Pipes conveying water for domestic purposes are frequently laid in close proximity to sewers. If a sewer is defective, polluted sub-soil water may be drawn into a leaky water main in the event of a negative pressure being produced, a condition that occurs sooner or later in every water system and, in the case of an intermittent supply, is an almost daily occurrence. Another reason for maintaining sewers in sound condition is the necessity for excluding gases which from various causes may accumulate in the ground. There is strong evidence that explosions that have occurred in sewers have been due to the admission of gas through defects

in the walls of the sewers—particularly in the upper portions—which would not normally be regarded as of serious importance.

Although sewers are constructed on self-cleansing lines, a certain amount of heavy detritus such as small gravel and sand is deposited along the invert. In main sewers constant sweeping and clearing is necessary, and adequate means of access must be provided for this purpose as well as for repairs, and the making of new connections. It is usual to provide a manhole at every change of direction and at intervals of not more than 100 yards.

The connection of tributaries to main sewers should be made in the direction of the flow and above the invert, so that the main flow is not checked and sewage does not "back up" into the small pipe when the larger flow is increased. The connection of drains to small pipe sewers should be made in a similar manner, but in the case of the larger sewers drains enter at right-angles through the brick walls at a point about two-thirds of the height above the invert. In many towns cast-iron flaps are placed on the outlets of the house drains in the main sewers. These flaps are so hung as to prevent the passage of rats from the sewer into the drain whilst offering little or no resistance to the flow of sewage.

The chemical composition of sewer air is subject to considerable variations. In well-ventilated sewers the composition closely approximates to that of outside air. It is dust-free, and there is usually a slight diminution in the amount of oxygen, with a corresponding increase of carbonic acid. In the case of badly ventilated sewers or "dead ends," however, the oxygen content may be greatly reduced, and sulphuretted hydrogen may be present in such an amount as to be actually poisonous. The continued inhalation of drain or sewer air has been thought to predispose to a general loss of health, *e.g.* anæmia, headache, vomiting, sore throat, skin eruptions, and diarrhœa, but no very definite evidence has been produced in favour of this view.

Disposal of sewage under water-carriage systems

Under the Rivers Pollution Prevention Act, 1876, it is an offence to discharge crude sewage into a stream, and a "stream" is defined as including the sea to such extent and tidal waters to such point as may after local inquiry and on sanitary grounds be determined by order of the Minister of Health. In those cases, however, where sewage was discharged or was about to be discharged at the time of the passing of the Act, it is a good defence to prove that every practicable means is taken to purify the sewage. The Act therefore particularly deals with the formation of new sources of pollution. Under the Salmon and Freshwater Fisheries Act, 1923, it is an offence to discharge into any waters containing fish any liquid or solid matter so as to cause

the water to be injurious to fish or their spawning grounds. A Fishery Board may, for the protection of the fisheries in their district, institute proceedings under the Rivers Pollution Prevention Act and it is provided that the Minister of Health may by order declare tidal waters to be a "stream" for the purpose of the protection of fisheries. The effect of such an order would be that the Rivers Pollution Prevention Act would apply to those waters and could be enforced, not only on sanitary grounds but on fishery grounds as well.

1. **Discharge into the sea.** This method, which is the most economical of all, is practicable for coastal towns, provided the outlet can be carried sufficiently far from the shore and in such a direction that the prevailing wind and currents will not drive the sewage landwards. It is usually advisable to screen the sewage or to break it up in disintegrators or special pumps. The outfall should be below the lowest tide level, and should be protected with a valve to prevent sea water backing up the sewer. If the foreshore is very flat tanks may have to be constructed to retain that portion of the sewage which would otherwise have to be discharged at low water. Many experiments with floats of various sorts have usually to be made prior to selecting a suitable place for the outfall, local conditions must be carefully studied and the possibility of infecting shell-fish layings must always be borne in mind.

2. **Treatment of water-carried sewage.** When discharge into the sea is not practicable local authorities have to make some arrangement for the purification of their sewage. Whatever method is adopted, the final effluent may have to be discharged into a stream of some sort, and certain standards have been fixed which determine the degree of purification necessary. The Royal Commission on Sewage Disposal recommended in its 8th Report that :—

1. No sewage effluent should contain more than 3 parts of suspended solids per 100,000.

2. Biological sewage demand—no sewage effluent should absorb more than 2 parts by weight of dissolved oxygen per 100,000 in 5 days at 18° C., and the stream after receiving the effluent should not absorb more than 0·4 part in the same time.

Certain important exceptions were made, depending on the size of the stream receiving the effluent.

1. When the stream is from 150 to 300 times the volume of the effluent, the standard of dissolved oxygen may be neglected, but the suspended solids should not exceed 6 parts per 100,000.

2. When the stream is from 300 to 500 times the volume of the effluent, solids in suspension should not exceed 15 parts. Ordinary sedimentation tanks would ensure this.

3. When the stream is more than 500 times the volume of

the effluent, all tests may be neglected, and the only treatment necessary is screening to remove the larger solid matters.

The aim of the two tests recommended by the Commission is to gauge the putrescibility and de-aerating power of the effluent and the possibility of a stream becoming silted up by an excessive amount of solids discharged into it. Bad effluents in time cause a nuisance in the streams receiving them, the growth of sewage fungus is encouraged, and fish life endangered. As many of our towns draw their water supply from rivers, every precaution should be taken to prevent pollution from such sources. The pollution of streams by trade wastes is receiving more and more attention and it has been suggested that there should be a central authority (*e.g.*, River Board) to hold the scales between the various interests concerned, and to be charged with the preservation of one of our greatest national assets—pure water.

Before any particular form of treatment is decided on, local conditions must be thoroughly studied. The flow of the sewage must be accurately gauged by actual measurement (*e.g.* over a weir) and the average dry weather flow (D.W.F.) calculated. The variations in flow must be noted. These will be found to be quite considerable in certain localities, depending on whether the town is a residential or a manufacturing one. The character of the sewage must also be determined. This can be done only by repeated analyses and by a study of any trade wastes that may be discharged into the sewers. Samples of sewage for analysis should be taken every hour for twenty-four hours on end, the amount collected at each sampling varying with the amount of sewage actually flowing through the sewer at the time. All these hourly samples are mixed, and an analysis made of a portion of the mixture. The following are analyses of sewages of various strengths :—

	Parts per 100,000.			
	Very strong.	Strong	Average.	Weak.
Free and saline ammonia . .	13·4	7·6	3·5	2·5
Albuminoid ammonia . .	1·75	1·4	0·9	0·6
Oxygen absorbed from permanganate in 4 hours at 80° F.	18·0	14·4	11·3	6·5
Chlorine	13·6	11·4	9·2	6·6
Solids in suspension . . .	42·0	34·0	29·0	26·0

Sewage from a purely residential town with a good water supply is the easiest to treat; that from an industrial town or a town with a less generous water supply offers much more difficulty. The various data having been obtained, the next

step is to decide on the form of treatment most suitable, and to select an area of ground for the necessary works. Sewage should flow by gravitation to the area selected, as lifting to a higher level will add greatly to the cost.

The various requirements of the average purification works are—

A. Preliminary treatment common to all types.

1. Arrangements for dealing with storm water.
2. Screening.
3. Detritus tanks.
4. Tank treatment proper.
5. Disposal of sludge.

B. Treatment of tank liquor.

1. Land treatment or
2. Artificial biological treatment.

(*a*) Aerating filter beds
(*b*) Contact beds
followed by humus tanks.

Preliminary treatment

1. **Storm water.** If a dual system of sewers has been installed, storm water will not have to be dealt with to any extent, but as the combined system is by far the more general, provision has usually to be made for excessive flow of sewage during periods of rain.

The Sewage Commissioners advised that an increase in the volume of sewage up to three times the dry weather flow should be dealt with in the works as ordinary sewage. Anything over three times the D.W.F. reaching the works should be run into special storm-water tanks capable of holding one quarter the D.W.F., though in many cases the sewers will have been relieved through storm overflows some distance from the works. By an arrangement of weirs, known as separating overflows, in the channel leading to the works any volume over three times the D.W.F. is directed to the storm-water tanks, while any volume up to three times is passed forward to the works for full treatment.

2. **Screening** is necessary to remove gross solids, such as lumps of fæces, pieces of paper, and various foreign bodies. As a rule, screens are made of vertical iron bars about 2 inches apart. In the past fine screens were employed, but disposal of the screenings has given so much trouble that fine screening is now rarely used except as an antecedent to centrifugal pumps, which may otherwise become choked. The screenings should be collected and disposed of daily, either by digging into a portion of land or by burning in an incinerator if one is available.

3. **Detritus tanks,** or grit chambers, are usually placed imme-

diately after the screens. They are small tanks arranged in couples, each tank being capable of holding about $\frac{1}{100}$ part of the D.W.F. Two tanks are necessary, as a daily cleansing is required ; hence, whilst one tank is having the solids removed from it the other is in use. The object of these tanks is to reduce the velocity of the sewage to such an extent that clean detritus is deposited, while organic matter passes along with the flow of sewage.

4. Tank treatment proper. So far only the coarser and heavier solids, including most of the mineral matter, have been dealt with. The sewage still contains much suspended matter that must be deposited or made to pass into solution before the sewage is ready for the next stage in the process of purification.

The most common form of tank treatment consists in allowing the sewage to flow continuously through sedimentation tanks of a total capacity of about eight to twelve hours' dry weather flow. There is a tendency to reduce the period of settlement when the next stage in purification is some process of aeration. Such tanks are usually rectangular in shape, the ratio of length to breadth being about 3 to 1. The depth is greater at the inlet than at the outlet end, the floor being laid with a fall of about 1 in 20. In most cases the minimum depth is 10 feet. The sewage enters the tank over a weir extending across the whole breadth of the tank, and flows out over a similar weir placed at a slightly lower level at the other end. Scum boards are usually fixed a short distance from the outlet weir, dipping about 18 inches under the surface of the liquid to prevent floating solids from being carried through to the aerating filters. Arrangements must always be provided for emptying the tank periodically and cleaning out the sludge. Several small tanks are better than one large one, and it is a good plan to have at least two reserve tanks, one to act as a relief during the process of sludging and the other to provide for an increase in the flow of the sewage during rainy weather. Occasionally tanks are worked in series, sewage being allowed to pass from one to the other. Quiescent sedimentation may also be practised. This means that the sewage is run into empty tanks where it is allowed to settle for two to four hours. By this method rather more solids are deposited.

The Dortmund or hopper-bottomed tank is another form of sedimentation tank which is largely used. It is really a conical tank sunk in the ground with its apex downwards. Sewage is led into the tank from above through a central pipe to a point well below the level of the surface. In this way the upper layers of liquid are kept more or less quiescent and the solids in suspension tend to deposit in the apex of the cone. Before the sewage can finally escape it has to pass upwards and over

peripheral weirs into a channel encircling the tank. When sludging is necessary a valve in the bottom of the tank is opened and the weight of water above the outlet forces the deposited solid matter out through the sludge pipe. Various modifications of this tank are in use in this country.

It may be necessary to add a precipitant to the sewage, especially where trade wastes such as those from breweries or tanneries have to be treated. In such a case a shorter period of sedimentation is usually given. The chemicals most commonly used are lime, alumino-ferric, and mixtures of lime and alumino-ferric or of lime and sulphate of iron. The amount of chemical added varies according to local circumstances, the total falling usually between 5 and 15 grains per gallon. These substances are generally added automatically to the sewage as it enters the works. Some arrangement of paddles or baffles should be provided to ensure thorough mixing. It should be remembered that the addition of a chemical precipitant to sewage increases the bulk of the sludge and may add to the difficulty of its disposal. In all forms of tank treatment, not only is much of the solid matter deposited as sludge, but also a proportion of the organic matter is rendered soluble by a process of putrefaction or septic action which is analogous to that of digestion and occurs to a great extent anaerobically. It was thought some years ago that, if sewage were held sufficiently long in a tank, all the organic matter would pass into solution and little or no sludge would remain. It was on this principle that Cameron of Exeter evolved his "Septic Tank." The difference between this and a sedimentation tank is very largely a difference of size in relation to the daily volume of the sewage and a difference in the manner in which the sewage enters and leaves the tank. In septic tanks the size of tank is larger in proportion to the flow of sewage, the sewage enters and leaves the tank below the surface of the liquid in order not to disturb the scum which forms, and sludge is removed as seldom as possible. In sedimentation tanks a smaller number of hours' flow of sewage is provided for, no attempt is made to encourage the formation of a scum, and sludging is more frequently practised. It is evident that fermentation proceeds much more vigorously in septic tanks than in sedimentation tanks and also that if sedimentation tanks are not frequently sludged they are apt to function to some extent as septic tanks.

The Imhoff or Emscher tank is a two-storey tank so designed as to permit of sedimentation of the sewage in the upper compartment and septic digestion of the sludge in the lower. The solids pass through a slot in the floor of the upper chamber into the digestion chamber below. This method aims at keeping the fresh sewage away from the decomposing sludge and its

advocates maintain that a better tank liquor is thus obtained. It is used extensively in Germany and in America.

The aim of tank treatment should be to produce a tank liquor containing not more than 6 parts of suspended matter per 100,000 and of a character that will lend itself readily to whatever process is to form the next stage in the treatment.

5. **Sludge.** Whatever tank is selected, arrangements must always be made for dealing with the sludge deposited in it. Where chemical precipitation is employed the volume of sludge is greater than with plain sedimentation. As a rule, sludge, as it is discharged from a tank, contains 80–95 per cent. of moisture. Of the solids present about half are mineral and the other half organic. It may be said that in chemical precipitation sludge will amount roughly to 30–40 tons per million gallons of sewage, in sedimentation 15–20 tons, and in septic tank treatment 10–15 tons.

Disposal of Sludge. (*a*) In the sea—as in London and Glasgow.

(*b*) On land. The best method is to run the sludge into shallow trenches and plough in, or it may be run over recently ploughed land and allowed to dry, but difficulty occurs in wet weather, and a good deal of nuisance from smell arises.

(*c*) Drying on sludge beds—that is running the sludge over specially prepared surfaces, where it lies till it loses most of its moisture, when it may be sold or given to farmers for manure. Wet weather frequently renders this method more or less useless, and unless the area is isolated the smell is likely to cause nuisance.

(*d*) Sludge-pressing by special machinery will remove from 30 to 35 per cent. of moisture. About 1 per cent. of lime is usually added to the sludge in the first place; the resulting cake, as it is called, is easily handled. It may be given away as manure, burned in an incinerator, or used for filling in waste land that is not likely to be used for building for many years to come.

(*e*) Digestion. By digestion is meant allowing the sludge to undergo fermentation of a particular type. Sewage sludge in the first place undergoes acid fermentation with a production of odours, but at the end of this stage a further fermentation sets in caused by other organisms. This latter fermentation, called methane fermentation, converts the sludge into an odourless material which drains rapidly on sludge drying beds. Sludge is retained for three to four months in special digestion tanks of a capacity equal to 2–3 cubic feet per head of population. The optimum temperature for this process is 75°–80° F. and in some works the sludge is heated to this temperature by means of steam pipes. The gas resulting from the fermentation or digestion can be collected and used for power purposes, *e.g.* for running the plant.

Treatment of tank liquor

In the great majority of cases this tank liquor will require further treatment, although in certain instances, where the volume of the stream receiving the sewage effluent is very much greater than that of the effluent, further treatment is not required (p. 490).

1. **Land treatment.** For this method plenty of land must be available at a reasonable price. Good land properly worked will produce an effluent containing fewer suspended solids than will any other process of purification. The best soils are light and porous with a subsoil of gravelly sand. Alluvial land is good. Sand, clay and peat are not satisfactory. Chalk is dangerous, on account of the possibility of pollution of water supplies through faults and fissures in the stratum.

Two methods of using land are practised—surface irrigation and intermittent land filtration.

Surface irrigation. In principle this consists in dosing land with liquid in such amount as will not interfere with the growth of vegetation. The quantity of liquid applied per acre must vary with the strength of the liquid and the suitability of the soil. Only about one quarter of the area will be under irrigation at any one time, as part of the land will be resting after a period of dosing. Generally speaking, when the sewage is of an ordinary domestic type, one acre of suitable land will suffice for 125–250 persons; this refers only to the area actually under irrigation. This will be equivalent to 30–80 persons per acre of the total irrigable area. The land must be carefully under-drained at a depth usually of from 4 to 6 feet. Main drains are 6 inches in diameter and tributary drains 4 inches. The latter are made of ordinary agricultural porous pipes. The distance between the different branch drains will depend on the type of subsoil. The liquid is led from the tanks in carriers, usually open concrete or stoneware channels, and distributed over the land in various ways. The ridge and furrow system is a common one. Here the liquid is run down the furrows, and crops, such as vegetables, are grown on the ridges. In the catch-water method carriers are run along the face of a slope so that water overflowing from one passes over the intervening ground before it is picked up by the lower carrier. A disadvantage is that the higher ground gets more liquid, and more impure liquid, than the lower areas. In other farms liquid is allowed to run evenly over the surface of the irrigated area. The final effluent from the under-drains is collected at one or more points and discharged into some adjacent stream.

The action of land is to purify by mechanical filtration, to fix and retain in the soil various organic matters held in sewage and to oxidise by the nitrifying organisms present. The process

is largely a natural biological one. The number of organisms in sewage is considerably reduced by land treatment, but pathogenic organisms may succeed in passing through the soil. Sewage-sick land is land that has had so much sewage applied to it that no alkaline bases remain to combine with the acids formed by the nitrifying organisms. The addition of from 1 to 2 tons of lime per acre, combined with a period of rest, usually suffices to restore the purifying properties of the soil.

The principal crops grown on sewage farms are rye-grass and cabbage, though some local authorities question the desirability of the production of vegetables under conditions which render them liable to contact with sewage and prefer that the land should be used for pasture.

Intermittent land filtration. Here the earth is made to act in much the same way as a sand filter is used for water purification. The growing of crops, if practised at all, should be a matter of secondary importance. The ground has usually to be specially prepared and very carefully under-drained. The surface soil is ploughed over periodically to break up the film of organic matter that always forms. One acre of such land will actually deal with the sewage of 750–1,000 persons, but, if the total irrigable area is under consideration, the allowance should not exceed more than 250–500 persons per acre.

2. **Artificial biological methods.**

(*a*) **Percolating or trickling filters** are really aerating beds, not filters. They consist usually of circular beds from 5 to 6 feet deep and up to 200 feet diameter, built of clinker or stone. The medium should not disintegrate through the action of the liquid, and should preferably be graded, the larger pieces (say 2½-inch diameter) being placed at the bottom and finer material (say ½-inch diameter) at the top. There may be a retaining circular wall of brickwork, but quite satisfactory results are obtained from placing larger lumps of clinker in the form of a loose surrounding wall. The floor of the bed contains drains for collecting the filtered liquid. Distribution of the tank liquor is performed usually by means of rotary arms driven by a constant head of water or by the intermittent discharge of a siphon. Oxygen is freely drawn into the interstices by the percolating fluid, and in time the pieces of clinker, etc., get coated with a slime of organic matter. Bacteria are plentiful and insect larvæ of various sorts abound. It is usual to run these filters as continuously as possible. If the tank liquor contains a fair amount of solids in suspension, the top layer of the filter may become clogged and “ ponding ” of the surface may result. Occasional rest is the best means of preventing such a condition. Algal growths sometimes form on the surface, and tend to interfere with the passage of the liquid through the filter and to prevent free aeration. It is said that the application of a 20 per

cent. solution of caustic soda will kill off such growths and keep the filter free for months to come without injuring the purification process in any way. The rate of filtration must depend on the quality of the tank liquor and the fineness of the filtering medium, but as a rule not more than 100 gallons per cubic yard should be applied daily in the case of weak sewage, and this amount should be reduced to 35 and 70 for strong and average sewage respectively. Occasionally these filters are made rectangular, and distributors are arranged so that they move bodily over the surface of the medium. Fixed distributors are sometimes employed, but they invariably result in an uneven dosing of the bed. Such filters, if properly worked, cause no nuisance. Myriads of small flies of the genus *Psychoda* breed in the medium, but they do no harm and are rarely found at any great distance from their breeding-place.

(*b*) **Contact beds** are really tanks filled with clinker or broken stone and their purpose is to permit aerobic action to take place. There is no advantage in grading the material. Such a bed is filled with tank liquor, allowed to stand full for a time, then emptied and left empty for several hours. The cycle usually followed is the eight-hour one—an hour to fill, two hours to stand full, one hour to empty, and four hours to rest. The capacity of a new bed, with the medium in place, is about one-half that of the empty tank As the bed matures the materials sink closer together and everything becomes coated with a slime of organic matter, with the result that the capacity is reduced to something like one-third that of the empty tank. As in the case of percolating filters, a good deal of animal life develops in the interstices of the filtering medium. Contact beds give good results under careful working. The process is, as before, an aerobic nitrifying one, due mainly to bacterial action. Air enters the bed in the intervals of rest that must always be given after each emptying. Both percolating filters and contact beds take some time to mature, and it is usually some weeks before nitrates appear to any extent in the final effluent. All the conditions favourable for nitrifying action—oxygen, moisture, and warmth—are found in the interior of such beds.

Contact beds are not now being installed, as percolating filters are regarded as much more efficient. With strong tank liquor containing factory wastes it may in some cases be necessary to pass the primary filter effluent through a secondary filter.

The effluent from percolating filters and contact beds is apt to contain a good deal of fine, light organic matter called humus. It is necessary to allow this to settle before discharging the final effluent into a stream. This may be done by passing the filter effluent through tanks of a capacity equal to about two hours' D.W.F. As a rule effluents from properly managed land

contain very little suspended matter, hence humus tanks are unnecessary.

Activated sludge system

In this process screened sewage, free from detritus, is agitated with specially ripened or activated sludge, the agitation being achieved either by means of compressed air forced through porous tile diffusers in the bottom of the tank or, as in the Sheffield or the Simplex systems, by means of agitators or paddles. The process would appear to be partly physical and partly biochemical. Activated sludge is obtained by aerating for some days sludge preferably from contact beds or percolating filters. In practice sewage, after being screened and passed through detritus tanks, is aerated for a period of from two to four hours in the presence of 7–10 per cent. of activated sludge as it flows continuously through an aerating tank. This is followed by passage through settlement tanks for another two to four hours. The sludge deposited in the settlement tanks is returned in part to mix with the sewage as it enters the aeration tank and the rest is run off to sludge drying beds. With careful management an activated sludge plant will give results falling well within the standards recommended by the Sewage Commissioners.

The cost of installing such a plant is no greater than that of ordinary tanks and filter beds, but maintenance costs are greater and skilled management is essential. The surplus sludge, which is not unlike humus from filter beds, is bulky and contains as much as 99 per cent. of water. It is apt to putrefy and is somewhat difficult to dispose of. It was thought at first that the activated sludge process would supersede all other methods of sewage purification, but it appears more likely that it will be used rather in association with settlement tanks and filters. In Birmingham, for instance, aerating tanks have been placed between settlement tanks and percolating filters with the result that two or three times the amount of liquid can be dealt with by the filters than was formerly the case. It has also been shown that 60 per cent. of purification takes place in the first hour of aeration, and only 32 per cent. in the next five. It is therefore more economical to give a short period of aeration and to finish off the treatment by means of percolating filters. (Students should consult "The Work of the Sanitary Engineer," Martin, A. J. (Macdonald and Evans, London), 1935.)

Sterilisation of sewage. Experiments have been carried out to determine what dose of disinfectant would be required to render tank liquors innocuous. The most useful index is a big reduction in the numbers of *Bact. coli.* Pure chlorine, bleaching powder and Chloros (containing 10 per cent available

chlorine) are the chemicals most commonly advised, and in an ordinary sewage one or other would have to be added in the proportion of at least 10 to 15 parts of available chlorine per million parts of sewage before any marked effect on the numbers of *Bact. coli* would be observed. In addition, a long period of contact would have to be given. The practice would add materially to the cost of sewage purification and has not been adopted in this country. It might be useful in the event of an outbreak of epidemic disease such as enteric fever.

In the past it was difficult to cultivate typhoid bacilli from sewage, but by improved technique Wilson has demonstrated on an average the presence of one *Bact. typhosum* in each cubic centimetre of Belfast sewage ("Isolation of Bact. typhosum, from Sewage and Shell Fish," *B.M.J.*, 23 June, 1928, pp. 1061–2, Wilson, W. J.). Gray in 1928 found paratyphoid bacilli in seven out of twenty specimens of Edinburgh sewage from a district in the city where an outbreak had occurred in 1927, and Begbie and Gibson in 1930 found the same organism in seven out of fifty-seven specimens from the Edinburgh main sewers although there had been no recent particular incidence of paratyphoid fever. At Epping paratyphoid bacilli were recovered from the sewage effluent five years after an outbreak of the disease (Annual Report of Chief Medical Officer, Ministry of Health, 1935).

Disposal of trade wastes. Under the Public Health (Drainage of Trade Premises) Act, 1937, traders have the right to discharge such wastes into sewers, subject to certain conditions (see p. 528). Trade wastes fall into three main groups—(*a*) wastes from stone quarries, china clay works and coal washeries—these contain solids in suspension and may usually be sufficiently purified by sedimentation, with or without chemical precipitation, followed sometimes by mechanical filtration; (*b*) wastes from tanneries, cotton bleach works and paper works—these contain solids in suspension and polluting substances in solution and require treatment by sedimentation, sometimes with chemical precipitation, followed in many cases by further purification by chemical and biological processes; (*c*) wastes containing polluting substances mainly in solution or colloidal dispersion, *e.g.* from gasworks, dairies and creameries—these need chemical or biological treatment or both. It may be found possible, *e.g.* in beet-sugar works, to re-use water after some simple treatment such as the addition of lime together with sedimentation. This reduces the bulk of waste water ultimately to be disposed of. It is often important to admit trade wastes to the sewers in controlled amounts, roughly in proportion to the flow of the sewage.

Milk factory wastes may be purified by sedimentation, dilution of the tank liquor to form a mixture of a known

biological oxygen demand, and treatment of the diluted liquor either by the activated sludge process or by passage through two percolating filters in series, the order of the filters being reversed at intervals of one to three weeks. (The Reports of the Water Pollution Research Board, Department of Scientific and Industrial Research, should be consulted in this connection. See also *The Surveyor*, 28th January, 1938, p. 187, "Treatment and Disposal of Trade Waste Waters"; *Analyst*, 1939, Vol. 64, pp. 252–260, "The Practical Treatment of Dairy Effluents," Scarlett, C. A.; "The Treatment and Disposal of Waste Waters from Dairies and Milk Products Factories," D.S.I.R. Water Pollution Research, Technical Paper No. 8, 1941.)

Small purification and disposal schemes. Installations in use for the purification and disposal of sewage from isolated buildings consist generally of a simple form of septic tank, designed to retain the sewage for a period of time sufficient to break up the solids and to allow insoluble matter to settle out as sludge, and a percolating filter or aeration bed, in which the effluent from the septic tank is purified aerobically. A humus tank may or may not be necessary. The final effluent should be fit for discharge into a stream, or it may be disposed of by irrigation on suitable land.

There is no definite rule as to the capacity of a septic tank; it should not, however, be too large. It is essential that the effluent should be comparatively fresh and not in a state of secondary decomposition. Generally the tank should hold something less than one day's flow of sewage. It should be long and narrow and deeper at the inlet end than at the outlet. Perforated baffles placed across the tank and dipping to two-thirds the depth assist to prevent the escape of solids at times of excessive flow. The inlet and outlet pipes are dipped to about one half the depth of the tank. During decomposition the specific gravity of the solids is lowered, they therefore float in the tank and, being trapped by the dipped outlet, form a scum in which they remain until decomposition is complete. The liquefying process is anaerobic; the tank may therefore be covered if necessary, but it should not be airtight.

The percolating bed must be thoroughly aerated. Where the fall of the land will permit, it may well be constructed above ground. If constructed underground it must be as open as possible. The depth should be not less than 3 feet 6 inches or more than 5 feet. The capacity should be approximately 1 cubic yard to every 40 gallons' flow of effluent. The best media are slag and hard well-vitrified clinker, the mesh varying from 2 inches at the bottom to $\frac{3}{4}$ inch for the upper layer. A simple dosing device is necessary to ensure even distribution of the liquid over the whole surface of the filter and adequate

aeration after each discharge. On no account must the filter be allowed to become water-logged. The outlet must always be at the bottom.

Where it is intended that final disposal shall be into a small slow running stream it is advisable that on leaving the filter the effluent should pass through a humus tank.

(*Health Bulletins*, Dept. of Pub. Health, Victoria, Australia, Nos. 53 and 54, January-June, 1938, pp. 1463 and 1500.)

Sullage water from camps, etc. The disposal of liquid wastes from kitchens, ablution benches and baths is frequently a more difficult problem than that of the disposal of excreta. This is due mainly to the large amount of these wastes and to the difficulty of disposing of them by ordinary soakage into the ground on account of their high grease content.

In the most elementary methods of disposal various forms of strainer traps, *e.g.* traps filled with hay, straw or brushwood, are used to intercept and retain solid contents, the liquid being first cooled sufficiently to allow grease, etc., to solidify. The strained effluent is then disposed of either in pits or by irrigation through or over prepared ground. These methods rarely suffice for the larger types of camp. In such cases a simple means of chemical precipitation may be adopted, the object being the production of a clear effluent, which may be disposed of in the ground, or discharged into a stream. Investigations at the Army School of Hygiene show that the most suitable precipitant is ferrous sulphate, the amount required varying according to the nature of the waste to be treated. Suitable addition of this chemical produces a heavy floc which settles rapidly, leaving the supernatant water clean. The success of the method depends upon adjusting the pH value of the waste water by the addition of lime, after dosage with ferrous sulphate. If this is properly carried out the effluent is fit for disposal by either of the means mentioned above. In practice the sullage water is collected into tanks—at least two are necessary to be used in rotation—the outlets for clear water being placed a few inches from the bottom. Ferrous sulphate and lime are added in the quantities indicated as necessary by a simple experiment on a 5-gallon sample. Precipitation is effected in from one to six hours, after which the clear effluent can be run off. If the effluent is finally discharged into a stream the dilution should be not less than 1 in 150, otherwise further treatment of the effluent is necessary to reduce the oxygen absorptive powers to 2 parts by weight per 100,000. (*J. Roy. Army M. Corps*, June, 1935, pp. 402–404, Hattersley, S. M.; June, 1938, pp. 374–378, Kennedy, T. F.; and July, 1938, pp. 8–22, Mackenzie, E. F. W., and Hilton-Sergeant, F. C.; also *J. Roy. San. Inst.*, January, 1942, pp. 62–70, Clay, H. H.)

DISPOSAL OF DRY REFUSE

Dry refuse should be kept in galvanised-iron receptacles pending removal. These should be cylindrical with a capacity of about $3\frac{1}{2}$ cubic feet. Emptying is facilitated if the diameter at the top is slightly greater than that at the bottom. Refuse is collected at least once a week, though in congested districts there may be a daily service. Fixed ashpits are unsatisfactory and are now rarely found, having been replaced by refuse bins under conversion schemes.

The composition of refuse varies both with the district (*i.e.* residential or industrial) and with the season of the year. Much of it is now consumed by householders in slow combustion stoves used for heating hot water. For a population of 100,000 75 tons of refuse per day, or 22,500 per annum, is a fair average. The approximate daily amount of household refuse may be calculated by the following formula :—

$$\frac{\text{Thousands of population}}{4} \times 3 = \text{quantity in tons.}$$

Thus for a population of 100,000

$$\frac{100 \times 3}{4} = 75 \text{ tons per day.}$$

Experience has shown that for collection of refuse different types of vehicles are required to meet varying circumstances ; a combination of horse-drawn and mechanical vehicles is usually the most economical, and all vans should have low loading lines which save labour in lifting refuse and obviate the use of ladders (*J. Inst. San. Engineers*, 1927, Vol. 31, pp. 93–102). Collecting vans should have effective covers to prevent dust discharge during transit.

During 1937–38 in the eighty-four areas outside London in which accurate records were kept, the average weight of refuse dealt with amounted to 14·5 cwts. per 1,000 persons per day. The average cost of collection and disposal was 16*s.* 1*d.* per ton. The comparable figures for London were 16·1 cwts., with an average cost of 20*s.* 10*d.* per ton. The expenditure of all local authorities in England and Wales falling on public funds in respect of collection and disposal of refuse and street cleansing amounted to £11,600,000 in 1936–37, the latest year for which figures are available.

There are five recognised methods for the disposal of refuse :—

(1) **Tipping or dumping on land.** The indiscriminate dumping of crude refuse invariably causes nuisance from fire, flies, and rats, and is now replaced by a controlled system which is free from this objection.

The disposal of house refuse by a system of controlled tipping

is particularly suitable in districts in which excavations, such as disused gravel pits, exist or where it is desirable to raise the level of small areas of land. Properly conducted and supervised, such a system can serve the double purpose of disposing of refuse cheaply and hygienically, and at the same time of reclaiming, for agricultural or public use, land which formerly may have been not only useless but a source of nuisance.

Experiments carried out at Manchester during 1932–33 with a series of tips formed of ordinary household ashbin refuse, 6 feet deep and covered with a layer or " seal " of separated fine ashes approximately 6 inches thick, showed that there was a rapid rise in temperature in the tips after sealing, peak temperatures ranging from 115° to 166° F. being reached in times varying from eight to fourteen days. These temperatures were of one to three days' duration, after which there was a gradual though not uniform fall to normal temperatures, the time taken being approximately three and a half months.

Excavation of the tips twelve months after sealing showed that all organic matter other than woody fibre had disappeared. Paper tipped loosely was decomposed, but paper tightly packed (books, etc.) had undergone little change. Ferrous metals were in an advanced stage of decomposition. The contents of the tips were innocuous and of some manurial value. (" Some Notes on the Scientific Aspects of Controlled Tipping," 1932–33, Jones and Owen, Cleansing Department, Manchester.)

The Ministry of Health have issued the following rules for the disposal of refuse by controlled tipping :—

(*a*) The refuse must be deposited in layers not exceeding 6 feet in depth ; each layer must be covered on all surfaces exposed to the air with at least 9 inches of earth or other suitable substance ; not more than 100 square yards of refuse may be left uncovered at any one time ; no refuse may be left uncovered for more than seventy-two hours ; screens must be provided to prevent paper and other debris from being blown away by the wind.

(*b*) No refuse must be deposited in water, and precautions must be taken to prevent the breeding of flies and vermin.

(*c*) If the refuse consists at any one time mainly of fish, animal, or other organic refuse, the deposit must be covered with at least 2 feet of earth.

(*d*) Tins and other vessels or loose debris must not be deposited in an exposed condition about the tip.

(*e*) Each layer of refuse which has been laid down and covered should be allowed to settle before the next layer is added, and if possible the deposit should not raise the surface of the tip above the general level of the adjoining ground.

In selecting a site for tipping the following must be considered :—

1. The distance of the tip from the collecting district.
2. Available sources of covering material.
3. Proximity of houses and buildings, etc.
4. The direction of the prevailing wind.

The road leading to the tip must be properly constructed and kept in repair; a sleeper track may be used in some areas.

Dust screened from house refuse, flue dust, road sweepings or soil, which is the best when obtainable, may be used for covering tips. When road sweepings are used paper must be burnt or buried.

Tip fires may be caused by children, the tipping of hot clinkers, or spontaneous combustion, and everything should be done to prevent them, as once started they are most difficult to extinguish.

When refuse tips are near residential property crickets which breed in them may be the cause of complaint, especially in warm weather. Poisons used for black beetles, such as sodium fluoride and borax mixed with bran or meal have proved effective in abating the nuisance. Other expedients are sealing the tip face with 6 inches of flue dust and sand and leaving this for three months, or as an extra measure the face and sides may be covered with sheets of hessian kept continually soaked in creosote. (See p. 195.)

(2) **Disposal in the sea.** This is rarely a practicable method of disposal. It must never be adopted where there is any risk of refuse being washed back on the foreshore. Hoppers usually carry the refuse some considerable distance out to sea. It may be necessary to store the crude refuse at the riverside to await the return of the hopper on account of inclement weather, and this may be a cause of nuisance.

(3) **Pulverisation.** It is the pulverisable organic matter that attracts flies and rats to a refuse tip. If all the materials of which refuse is composed are crushed together and thoroughly mixed, the resulting composition is said to be unattractive to rats and flies, innocuous and incombustible. The mixture possesses some fertilising properties and is useful for lightening heavy soils. The process is sometimes used simply as a preliminary to dumping, but if it is the intention to reduce the cost of the process by selling the resulting product to farmers the market prospects should be known to be reasonably good before the plant is put down.

(4) **Incineration.** Various patterns of incinerators are on the market. In one of the most popular, the refuse is shot into special furnaces from a top feed, while the resulting clinker is removed from the front of the furnace. Forced draught and means for preventing the emission of noxious gases and dust

from the chimney stack are necessary. The heat generated may be utilised to produce steam for various purposes and the clinker may be used in the making of roads and filter beds, and in the manufacture of paving slabs and concrete blocks. The most modern practice is to combine incineration with some form of salvage as in the following method.

(5) **Separation process.** The refuse on arrival at the works is discharged into receiving hoppers fitted with mechanical conveyors which automatically transfer the refuse to covered-in screens, usually of the rotary type. These screens, if adapted for the extraction of the fine dust only, are formed with a single mesh, but if cinder is to be separated the refuse is made to pass two successive meshes of appropriate sizes in a single screen. The dust, which often amounts to 40 per cent. of the total weight of the refuse, and the cinder, frequently over 30 per cent., are passed to separate hoppers. The dust is later used for lightening heavy soils or for other purposes, or, if not so utilised, is deposited on suitable and convenient land. The cinder is used for steam raising, either on the works or at private premises, or it may be left in the residual debris of the separation process and mechanically conveyed to the furnaces for ordinary incineration. From the screen the dustless refuse is conveyed on suitable belts to the furnaces or other means of final disposal, and whilst in transit the metals are removed magnetically or by hand, and afterwards baled and sold as scrap-metal. Other saleable materials are salved as and when markets are favourable, but textile materials should not be abstracted except in towns where the quantity is large enough to justify the provision of a special washing and sterilisation plant.

When suitable and convenient land is available for disposal of the fine dust, the separation process can be varied to meet local requirements. A more reliable steam supply can be provided with cinder as a fuel and the amount of steam produced for each pound of material burnt is much greater than in the case of mixed refuse used in ordinary "destructor" practice; the preliminary elimination of dust reduces handling and minimises the risk of nuisance from the discharge of grit from the chimney; the clinker is of good quality and capable of many uses.

The management of the collection and disposal of refuse should be on a costing basis, and accurate records should be kept of the cost and of the quantity of refuse handled based on actual weighings. These records should be examined monthly and an inquiry held when there is an undue rise for any period. The possibility of obtaining income from refuse should always be considered, and in this connection one local authority recovered £1,400 in one year from the sale of clean paper for the manufacture of cardboard and brown paper, while another obtained £600 from the salvage of bottles. The charging of

traders for the removal of their trade refuse is another matter worthy of attention. Local authorities may exercise discretionary power to charge, except in the case of hotels and restaurants, and there appears to be no valid reason for the free removal of large quantities of trade refuse from shops as distinct from house refuse.

" Hyganic " process. This process consists of the inoculation of refuse with a culture of bacteria after the saleable material has been salved and ashes and fine dust have been removed by screening. It is then subjected to anaerobic fermentation and afterwards to mechanical aeration. The final product is a dark brown moist material containing 37–44 per cent. of organic matter which is said to be suitable for manure. (*Journal Inst. Municipal and County Engineers*, October, 1938, pp. 1910–1917.)

Composting—the " Indore " process. This process, still in the experimental stage, is useful primarily where the organic content of town's refuse is high and excreta in bucket latrines (night-soil) have also to be disposed of. The main objective is the conversion of these waste matters to humus of manurial value. Alternate layers of refuse and of night-soil about 3 inches deep are placed in shallow brick-lined pits to a depth of about 2 feet 6 inches. If necessary the layers are slightly moistened during the filling process. The deposited material is turned at intervals of about fourteen days. At the end of two months the mass is removed from the pit and stacked in rectangular heaps, 10 feet broad at the base, 9 feet at the top and 3 feet 6 inches high, and allowed to " ripen " for one month, after which it is ready for application to agricultural land. This process is proving useful, particularly in the tropics. (*J. Roy. San. Inst.*, October, 1938, pp. 279–286, " Manufacture of Humus by the Indore Process," Sir Albert Howard.)

Garchey system of refuse disposal. This system is intended primarily to serve blocks of flats and similar suitably grouped domestic buildings. Refuse is deposited by the householder in a trapped sink and is washed by the ordinary sink waste water down a chute into a collecting chamber, which may be common to several chutes and sometimes to several blocks of buildings. The surplus flush water flows away by means of an overflow pipe to the nearest drain, and periodically—once or twice daily—the refuse is drawn by suction from the collecting chamber to a hydro-extractor at a refuse disposal station. When the refuse is sufficiently dry it falls into an incinerator, where it is destroyed. The system is in operation in Paris, and in this country, notably in Leeds. (*J. Roy. San. Inst.*, October, 1940, pp. 37–47, Jervis, J. J.)

SECTION IX

SITES AND BUILDING CONSTRUCTION

Plans

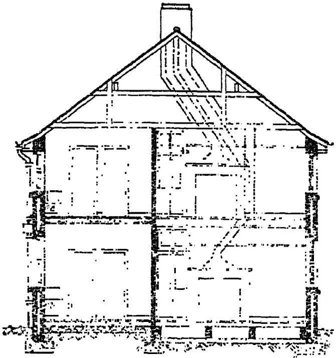
Before any constructional work can proceed it must be designed and delineated by means of drawings so made and arranged that the whole of the intended works and their effect, if any, upon existing works or premises are indicated. The details which it is possible to show upon a single drawing are necessarily incomplete, and, in order that a true and complete representation of any scheme may be conveyed, drawings dealing with each of the three dimensions, as well as with superficial appearances, are required. These are known as plans, sections, and elevations, and together are known technically as a " set " of drawings.

Plans are drawings on the horizontal plane only. Usually they are taken at ground level (to show foundations) and through each floor or storey at a point immediately above window-sill level. Plans can therefore indicate two dimensions only—length and breadth, but not height.

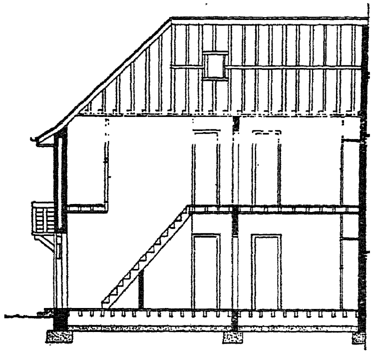
Sections are drawings on the vertical plane; therefore height or depth is indicated. At least two of these drawings, longitudinal and cross sections, are necessary. The lines at which the sections are taken are indicated upon one of the plans, usually that of the ground floor.

Elevations are drawings of the façades of a building. They deal with external details only, their object being to portray the exterior of the building as finished.

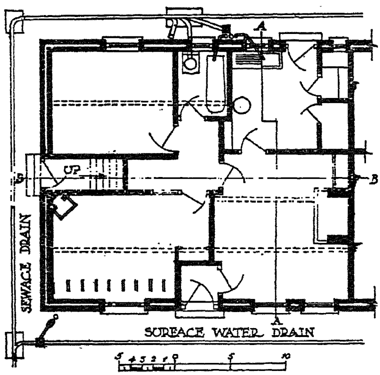
For purposes of public administration it is important that in any set of plans not only the design and character of the building concerned should be shown, but its position in relation to and its effect, if any, upon adjoining property should be made clear. These points are dealt with by means of a " site " or " block " plan. In the first instance a site plan is usually copied from one of the large-scale ordnance maps. The plan should show the true shape and extent of the site and should include property in its immediate environment. The shape and position of buildings demolished, if any, as well as of buildings contemplated or concerned should be clearly shown so that their relationship to the site itself and to roads and adjoining premises may be determined. The building dealt



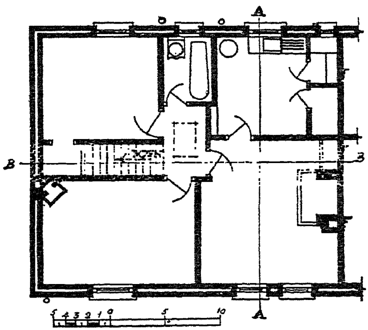
Section on line A-A showing width and height of rooms; construction of walls and floors; relation of floors to ground level; concrete over the site; depth of footings; height of door and window openings; height of fittings and fixtures; construction of fireplaces and construction and pitch of roof.



Section on line B-B showing length and height of rooms; construction of walls and floors; construction of ground floor through centre of house; concrete over site; pitch of staircase and number of stairs; details of timbering to ceilings and roof; pitch of roof at end of building.

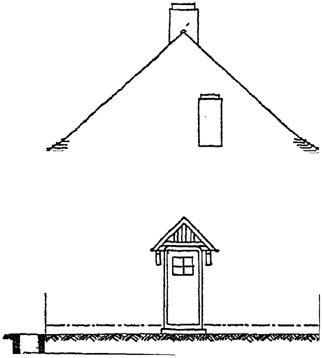


Ground-floor plan showing size and shape of building; construction of walls; size and layout of rooms, passages, etc.; position and width of window openings; width and hanging of doors; position of sanitary and other fixtures; layout of drains; dotted lines show walls supporting floor. Note also section lines A-A and B-B.



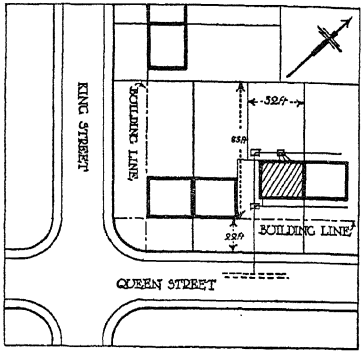
First-floor plan showing construction of walls; size and layout of rooms, staircase and landing; position and width of window openings; width and hanging of doors; position of sanitary and other fixtures; flues from fireplaces on ground floor. Skylight (above level of the plan) shown in dotted lines.

FIG. 13.

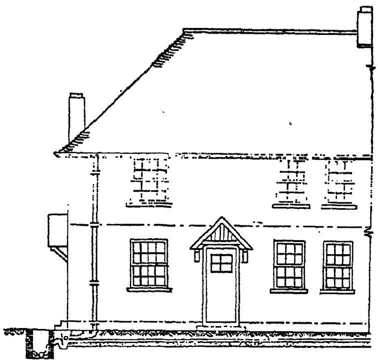


End elevation showing features similar to the others, also details of the entrance; pitch of the roof at back and front, also the height and width of chimneys.

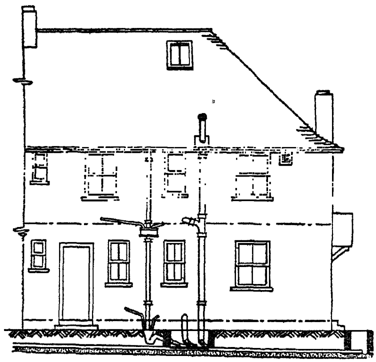
The main drain from back to front, with two access chambers, is shown in section.



Block plan showing orientation; shape and extent of site and its relation to roads; width of roads; building lines; position of building on site and its relation to adjoining buildings. The drain, used in common with adjoining buildings, is also indicated.



Front elevation showing external appearance of the house as viewed from the front; size, position, and design of windows and external door; gutters, rain-water pipes, chimneys, and the pitch of the hipped end of the roof. Dotted lines show the floor levels.



Back elevation showing similar features; also skylight in the roof; position of rain-water, waste and soil pipes and their connections to the drain. The drawing is extended below ground level to show construction and fall of the drainage system.

FIG. 14.

with by the plan should be cross-hatched or otherwise clearly indicated. The points of the compass also should be shown on the block plan.

The points dealt with above may be made clearer by reference to Figs. 13 and 14, which are drawings of a small semi-detached building containing two workmen's flats.

A set of drawings—plans, sections, and elevations—must be regarded as units complementary one to another and as parts of a whole. They must therefore be read not only individually but together, the details given by one being checked against those of the others. In practice it is best to proceed by reading the plans first, starting with the ground-floor plan. These should be read and compared with the sections, and afterwards with the elevations.

It is obviously not possible to represent buildings or constructional works and schemes by drawings made full size; the drawings are therefore always reduced to a ratio or scale, *e.g.* $\frac{1}{8}$ of an inch to 1 foot, which is $\frac{1}{96}$ full size. A drawing is useless unless the scale is indicated upon it, and the task of reading plans is simplified considerably if the scale is actually reproduced on each drawing. However accurate a drawing may be it is never safe to rely upon scale measurements for any but the more general details; all finer measurements, particularly those in which legal and other contentious points are involved, should be dealt with specifically on the drawings by exact (figured) dimensions.

Sites and dwellings

A building intended for human habitation should be satisfactory in respect of site, aspect, and air space; it must possess an adequate supply of wholesome water, suitable provision for disposal of sewage and house refuse, and be of sound construction.

The **site** should be dry and unpolluted. Sand, gravel, and porous soils in general are good, as they are warm, and, as their power of retention is small, water easily runs away. Chalk, sandstones, and limestones are also good. The clays are, generally speaking, bad, as they are damp and cold. A syncline of clay filled with sand or gravel, otherwise a "gravel pocket," is particularly undesirable, as almost invariably it is waterlogged. Land made up by the tipping of house refuse never makes a really satisfactory site. In suitable circumstances a damp site may be rendered comparatively dry by a system of subsoil drainage. An elevated site is usually best.

Aspect. Due consideration should be given to sunshine, wind, and rain. In England on the longest day the sun rises in the north-east and sets in the north-west. On the shortest day

it rises in the south-east and sets in the south-west. A northerly aspect thus receives the least amount of sunshine, and, therefore, kitchens, foodstores, and the like should be made to face north. On the other hand, a southern aspect receives the maximum amount of sunshine. Although in many respects this may be considered advisable, a wall so situated faces the sun during the hottest hours of the day, from 2 p.m. to 5 p.m. In view of this a south-easterly aspect is in all probability the best. The south-east is also the dry quarter; it escapes the prevailing south-west wind and also the cold north-east wind. (The bylaws relating to the open space around buildings will be found on p. 535.)

Building materials. A good brick weighs about 6 lbs., and measures about $9 \times 4\frac{1}{4} \times 2\frac{3}{4}$ inches. It should be made of well-burnt clay, be regular in shape, free from flaws, absorb not more than 15 per cent. of its own weight of water, and when struck give a metallic ring. Of the stones, limestone and sandstone are most commonly employed. The limestones consist chiefly of calcium carbonate, although dolomite contains magnesium carbonate as well. They should not absorb more than 10 per cent. of water. The sandstones include all stones whose grains consist of silica. The material which cements the grains together determines the hardness of the stone and also its name. Thus, in the case of red sandstone, iron is the cementing substance. They should not absorb more than 8 per cent. of water.

Slates should be hard, uniform in size and thickness, and absorb not more than 5 per cent. of water after immersion for twenty-four hours. Tiles are made of burnt clay, and are therefore more porous than slates, but they should be as little absorbent as possible.

Lime is made by burning chalk or limestone. The $CaCO_3$ is decomposed into CaO and CO_2, the latter escaping into the air. When water is added to quicklime, that is CaO, slaked lime, $Ca(OH)_2$, results. Pure lime has little strength in itself. It is the impurities which lime contains, such as clay and, to a less extent, iron oxide, that give it its cementing powers and the property of setting into a hard mass. Hydraulic limes are those which set when immersed in water. Ordinary chalk produces a lime which is only feebly hydraulic, but lias lime is markedly hydraulic. This varying degree of hydraulicity is due almost entirely to the amount of clay impurity. Limes containing 20–30 per cent. of clay are very hydraulic and great difficulty is experienced in slaking them.

Lime mortar is made by mixing 1 part of lime with 3 parts of clean, sharp sand. Ordinary sea sand is unsuitable, as the particles are rounded off by attrition and sharpness is essential. In order to allow the slaking to complete itself lime

mortar should be made and kept for some time before being used, otherwise damage may occur to the brickwork, as heat is evolved and expansion takes place during the process of slaking.

Roman cement is made by calcining certain stone found in the neighbourhood of the Isle of Sheppey. It contains calcium carbonate, silica and alumina, and is heated sufficiently to drive off the carbonic acid, but not far enough to clinker. It is then finely ground. When mixed with water it sets quickly. It is not so strong as Portland cement.

Portland cement has the same composition as Roman cement, but the heating is continued to the clinkering stage. The vitrified masses are then ground into a state of very fine division. When mixed with water it starts to set almost at once, and in the course of time becomes an enduring mass practically impervious to moisture.

Concrete is made by mixing together with water 1 part of Portland cement, 2 parts of sharp sand, and 4 parts of gravel, broken stone, or brick. The coarse constituents of concrete are known as "aggregate." Lime may take the place of cement where no excessive strength is required.

Although it is quite possible, by the use of good materials properly proportioned, graded, and mixed, to render concrete waterproof, this can rarely be achieved except by very special care and supervision. Many so-called waterproofers are available to remedy deficiencies in this respect. They vary in form from powders or liquids to be added to the Portland cement in the process of mixing, to solutions for application to the finished material when completely set. Some of these materials can certainly reduce the permeability of good concrete, but they cannot improve an inferior concrete. Where waterproofers are used it is of the utmost importance that thorough and even mixing should be obtained, for they are valueless unless evenly distributed throughout the mass. Waterproofers for surface application usually have as a base some form of wax dissolved in a suitable "carrier," which after application dries or evaporates and leaves a water-resisting film on the surfaces treated. The life of such a film is necessarily limited.

Of the cements used for internal decorations and for the coating of walls, Keene's and Parian cements are most commonly employed. Keene's cement is made by steeping gypsum ($CaSO_4$) in a solution containing 1 part of borax, 1 part of cream of tartar, and 18 parts of water. When the gypsum is thoroughly impregnated with the salts, it is dried, burnt, and ground to a fine powder. Parian cement is a mixture of gypsum and dried borax, burnt and finely ground. Both these cements are easy to work and set very hard.

An excellent plaster for the finishing coat of walls within buildings is a mixture of 2 parts of lime putty to 1 of clean fine sand. The lime putty is made by slaking quicklime to a thin slurry and passing it through a fine sieve. The slurry is left to thicken for at least seven days, when it is ready for use. Walls finished in this material whilst hard enough for ordinary purposes are warmer and less resonant than those finished in hard materials, such as Keene's or Parian cement.

The chief woods are oak, ash, beech, teak, elm, pine, and fir. They should be free from cracks and loose knots, and should be well seasoned. By seasoning is meant the drying up or the washing out of the sap. Immersion in running water and subsequent drying, exposure to hot air, or stacking so as to allow air to circulate through and around the stack, are among the methods adopted for this purpose. Well-seasoned timber is not readily susceptible to the form of decay known as dry rot.

Construction. By good construction is meant strength, durability, freedom from dampness, and resistance to fire.

Walls are usually constructed of brick, stone, or concrete. When a wall is built, wide courses or expansions, known as footings, are placed at its base to distribute the pressure of the superimposed structure over a sufficient area. The lowest footing should be twice the width of the wall. In order further to distribute the pressure, a concrete foundation is provided. The concrete must be at least 6 inches thick, but this varies with the height and thickness of the wall and the nature of the soil. It should project laterally beyond the lowest footing by at least 6 inches on each side.

The "bond" of a wall is the way in which the bricks are laid so as to form a homogeneous mass, no vertical joint being placed immediately over a similar joint. The English and Flemish bonds are the two mostly employed. The long side of a brick is known as the "stretcher" and the end as the "header." The English bond consists of alternate courses of "stretchers" and "headers," the Flemish bond of alternate "stretchers" and "headers" in the same course. Walls so bonded must be at least 9 inches thick. When a height of 25 feet or a length of 30 feet is exceeded, walls are required to be of greater thickness. Internal walls which carry weight should also be of brickwork, but for partition walls hollow blocks made from a special "moler" earth composed of minute fossil silica shells and natural alumina are now largely used; they are light in weight, of great mechanical strength, and of considerable insulating and sound-resisting qualities. A cheaper form of block for the same purpose is manufactured from concrete composed of small broken coke and Portland cement. Walls so constructed and plastered with the lime plaster previously described are light, tough, durable, and sound-resisting, and are not affected

by the condensation of atmospheric moisture in cold weather; an additional advantage is that they do not readily harbour vermin.

Lath and plaster partitions are not now used in any but the cheaper type of building. Expanded metal is used in the place of wood lathing. Internal walls should be coated with hard durable oil-bound distemper or washable paint. In the case of sculleries, bathrooms, larders, water-closets, etc., tiles or glazed bricks are highly recommended. Wall-paper harbours dirt and is difficult to clean.

Where in order to meet the question of first cost and other considerations it is necessary to adopt an alternative to brick construction, the method which possesses the greatest possibilities is timber framing. This is particularly suitable for rural housing, and may be adopted with advantage for other buildings, such as schools (Board of Education Circular, 1419, 22nd July, 1932). It is true that the timber building has disadvantages, such as liability to fire or to dry rot, but these can be overcome. If placed on a brick or concrete foundation and guarded against dampness in the same way as brick structures are guarded, a timber-framed building has a life of at least forty years, and, with reasonable care in the choice and preliminary treatment of timber, such buildings may be made to last for twice that period. The lasting properties of oak, ash, elm, and larch are not sufficiently appreciated.

The principal materials used for roofs of permanent buildings are slates, tiles, thatch, wood, lead, zinc, copper, and asphalt. For light temporary buildings roofs are constructed of corrugated iron or asbestos-cement sheetings, and various felts waterproofed with rubber or bitumin. The "pitch" of a roof covered with lapped units such as slates or tiles should not be less than 45°. In exposed positions roofs should first be covered with felt to exclude cold wind, fine snow, dust, etc. Thatch, and wood in the form of shingles, are artistic but inflammable and afford harbourage for vermin. Where a pitched roof finishes against a party-wall, or where a chimney passes through it, the junction of the roof with the wall should be made water-tight by means of a sheet-metal "flashing." Metals are used principally for flat roofs. Aluminium foil on bitumen roofing felt (Turnall) is an excellent insulator if placed beneath, and separated by, an air-space from a metal roof. (*J. Inst. Heating and Ventilating Engineers*, December, 1934, Crowden.) Flat concrete roofs are covered with rock asphalt approximately 1 inch in thickness. The material is applied in a mastic condition while hot, and, to exclude possibility of defect, should be laid in two coats.

Floors should be specially constructed for the purposes they are to serve. In kitchens, sculleries, bathrooms, and similar

places they should be of a hard, impermeable, and preferably jointless material. Wood is commonly used for living-rooms, and with proper construction there is no better material. A parquet floor of oak or teak blocks is exceptionally good; yellow deal or pitch pine is less expensive and quite satisfactory. With plain boards laid edge to edge, open joints are always liable to occur. These become receptacles for dirt which can never be removed, and may harbour vermin. On ground floors, where the under-floor space is ventilated, open joints between floor boards are a source of draught which seriously interferes with the arrangements for heating the rooms. To prevent these troubles floor boards should never exceed 4 inches in width and the edges should be grooved and tongued, the tongue of one fitting

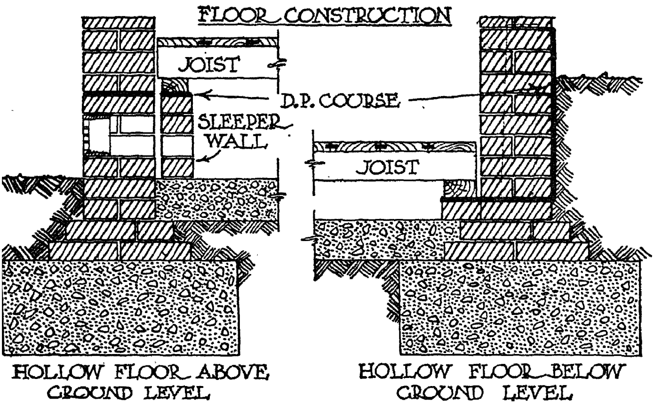


FIG. 15.

tightly into the groove of the other. In this way, if the timber is dry and well seasoned when laid, a solid floor is obtained.

As far as possible the materials used should be incombustible. Much research work has been devoted to processes for imparting fire-resisting qualities to wood. One of the most satisfactory methods is known as the Oxylene process. To reduce the risk of fire spreading from one house to another no wood is allowed to be inserted in a party-wall, *i.e.* the dividing wall of two joined buildings, unless between the centre of the wall and the wood there is brickwork at least 4½ inches in thickness. For large buildings reinforced concrete or ferro-concrete is extensively employed. This consists of ordinary concrete in which bars of steel are embedded. The introduction of the steel strengthens the concrete by taking the tensile strains; in addition to this it renders the building more fire-resisting.

Under the influence of great heat, however, steel under compression will buckle and endanger the stability of the building. No material is absolutely proof against fire; hence the advisability of using the expression "fire-resisting."

It is important that buildings should be as free as possible from objectionable noise. The conduction of internal noise throughout a building can be reduced in large measure by the adoption of various devices during the construction of the premises. This is a matter to which insufficient attention has been given in the past and which is becoming of great importance in view of the increasing use of steel framework and reinforced concrete in buildings of all kinds. External noise entering a room through wall openings may best be dealt with by installing double windows glazed with ¼-inch plate glass with a space of at least 7 inches between the two window frames. In modern buildings, especially those in which hard internal furnishings are found, certain rooms may be almost unusable on account of reverberation or echo. It is now possible to reduce the "reverberation period," as it is called, to one second or less by applying to the walls and ceiling some acoustic absorbent material. Most of these materials consist mainly of asbestos and many reflect only 30 per cent. of sound waves. (Department of Scientific and Industrial Research, Building Research Bulletin, No. 14, 1934.)

Dampness. There is no definition of "damp" which is simple and practical enough for ordinary use. An attempt has been made to distinguish temporary from persistent damp, but it must be remembered that damp which may be temporary in a rich man's house is usually persistent in the case of the poor. (Report on Damp Houses, *Roy. Inst. Brit. Architects,* 1929.)

Walls are liable to dampness from three principal causes:—

(1) Dampness rising from the ground through the porous substance of the wall by capillarity.

(2) Dampness passing downward through exposed parts, such as parapet walls, chimneys, etc.

(3) Dampness due to infiltration of rain through the wall from its face.

The first two of these causes may be guarded against by layers or courses of impermeable material so placed that they will effectively prevent the passage of dampness from below or from above (see Fig. 15). These are known as damp-proof courses. They must be suitably placed and must be composed of a hard impermeable material, which should be as durable as the building itself. Materials in common use are asphalt, slate, lead, and vitrified bricks. Asphalt has several advantages. Being applied whilst hot and in mastic condition it is jointless and can be used with equal efficiency on vertical or horizontal surfaces. A thickness of 1 inch is sufficient. Slates and

vitrified bricks must be used in double thickness, bonded, and set in cement. Lead is excellent for horizontal positions. If laid in contact with cement it should be coated with a bituminous material to prevent corrosion. As an adjunct to the damp-proof course the surface of the ground against a wall should be covered with paving having a slope away from the building. Where this is not possible, as in the case of a garden, the wall surface should be cement-covered to a point up to, or if necessary above, the level of the damp-proof course.

Dampness due to infiltration of rain occurs chiefly in exposed positions, and in the case of new buildings is guarded against by the construction of hollow walls, *i.e.* two separate walls built with a cavity 2 inches in width between them. The two walls are bound or bonded together by metal ties protected against corrosion. Greater strength is obtained by increasing the thickness of the inner wall as required. The outer wall is never more than 4½ inches thick. Existing solid walls may be protected where necessary by " tile-hanging," or by " rendering " the outer surface with a waterproof coating of cement mortar (1 part cement to 2 parts fine washed sand) 1 inch in thickness. This should be applied in two coats. A pleasing effect can be produced by what is known as " pebble-dashing," small graded stones being dashed into the second coat of cement immediately after it is applied. The external surfaces of joints in brickwork should be properly pointed, *i.e.* bevelled to a smooth surface, so as to throw off rain and prevent its entrance into the thickness of the wall. In old brickwork the exposed mortar deteriorates and falls out, leaving the joints open. These should be filled or pointed with a composition of 1 part Portland cement and 2 parts sharp washed sand.

In addition to the precautions against dampness mentioned above, the whole site under a building must be covered with concrete to prevent the damp ground air rising and gaining access to the building, and provision must be made for ventilating the space between the concrete and the floor above it. For this purpose air-bricks are placed so as to ensure free ventilation through the whole of the space below ground floors, and any similar spaces where dampness is likely to occur (see Fig. 15). This provision for ventilation is also important as a preventive measure against the decay of timber by dry rot, the principal causative agent of which (*Merulius lacrymans*) grows only in a still, dark, damp atmosphere and at warm, even temperatures.

The damp-proofing of basements is a problem calling for special treatment. The most satisfactory method is to excavate the outside earth to a point below floor level and form an open area along any wall the face of which normally would be in contact with the earth. The area should be properly paved and

drained. Where this is not practicable a vertical damp-proof course is required either in the thickness of the wall itself or on the exterior of the wall and extending from a horizontal damp-proof course below the floor up to at least 6 inches above ground level, as shown in Fig. 15. This treatment is suitable only in cases where it is necessary to intercept the action of ordinary capillarity. Where, however, the subsoil water actually rises or is liable to rise to floor level, or where for any reason the basement is liable to flooding, the damp-proof course must pass under the floor, and cover the whole of the site as well as the walls. The damp-proofing of the tops of walls, parapets, etc., is effected by coping-stones or tiles set in cement. Chimneys are protected by double courses of tiles or similar provision placed at some point above the roof level.

Rainwater falling upon impermeable surfaces, such as windows and doors, is discharged on to the sills placed at the bottom of these openings. The under sides of all such sills should be throated or grooved along their length. If this is not done water is held up by capillary attraction, and instead of dripping clear, soaks into the wall.

A frequent cause of dampness in buildings, and one which is not affected by the use of damp-proof courses, is condensation of aqueous vapour in the air. The fundamental cause is the lowering of the temperature of moist air in contact with a cold wall to below dew point, the resultant condensed water being deposited on the wall surface. The obvious remedy is ventilation and suitable provision for heating, but solution of the problem is greatly assisted by finishing wall surfaces with an insulating and absorbent plaster, such as the lime-plaster previously described, rather than with dense cold materials such as Portland cement.

In newly erected houses signs of dampness are quite common during the first year. These usually take the form of patches of dampness and discoloration more or less evenly distributed over the interior surfaces of walls. They are due to a variety of causes connected with the water used in the construction of the walls and should disappear in the course of time.

Dampness resulting from faulty construction generally starts at ground level, or is traceable to one or other of the causes already dealt with or to defective rainwater spouts or roofs. In old houses in order to conceal signs of capillary dampness at ground level it is a common practice to panel the interior to a height of about 4 feet. This is a useless and improper proceeding, and walls so treated should be closely inspected.

House inspection. Inspections under the Housing Acts are made for the purpose of ascertaining and recording the con-

dition of houses themselves and the manner in which they affect, or are affected by, their environment (see Housing Act, 1936, and Housing Consolidated Regulations, 1925 and 1932, pp. 622 and 623).

For general purposes house inspections should be thorough and complete, and reports framed upon them should convey a true conception of the character and condition of the premises and of their environment. House-to-house inspections throughout a district should be uniform in character following a carefully drawn up plan. It is customary in many districts to use an inspection form which is filled up in respect of each house, but provided a routine plan is followed this is not really necessary.

The following is a suitable schedule of inspection :—

Date of Inspection.

Address. Full address, and note whether in Metropolitan Borough, Urban District, etc.

Ownership. Name and address of "*Owner*," "*Agent*," or "*Person having control of the premises*."

Brief Statements. (*a*) Type of street, its orientation and environment.

(*b*) Description of the house itself, thus :

Position in street.

Character ("detached," "semi-detached," or "terrace").

Construction ("brick-built and slated," etc.).

Height (number of storeys).

Means of approach (entrance direct from public way or through forecourt, etc.).

Open spaces or areas, front and rear.

Any business provided for or carried

INSPECTION

Exterior. *Front.* Condition of brickwork, evidence of dampness—especially at ground level, near rain-water pipes, eaves, gutters, parapets, etc.

Rear. As above, also :

Outbuildings, wash-house, water-closets—position, structure and general condition.

Open Spaces—approx. area of yards, etc., belonging to the premises, and whether these are enclosed or adjoin other open spaces.

Pavings. Construction, condition, and whether falling to suitable and sufficient drain openings.

Roof. Note as far as possible type and condition of roof of main building and of the outbuildings.

Interior. *Basement* (if any).

How approached.

Depth below adjoining ground (approx.) at both front and rear, with width of areas.

Number of rooms, whether let separately or habitually used as sleeping places. Inspect and note condition, lighting, and ventilation of each room separately.

Condition of floors, walls (noting evidence of dampness). Windows, fireplaces (means of cooking), storage of food. Evidence of vermin.

Ground floor / *First floor* } Routine inspection, room by room, front to rear, as above.

Staircase and passages. Condition of walls, ceilings, stair-treads and balusters, also means of lighting—natural and artificial.

General. *Drainage.* Number and position of manholes. Position and types of soil pipes, ventilating pipes, waste pipes, rainwater pipes, gutters, gulleys, sinks, etc. Result of chemical test.

Water-closets. Condition of water-closet apparatus and of the closet apartments. Note size of windows.

Water supply. Number and position of taps (pressure will indicate whether or not "direct from the main"). Position, covering, and, if possible, condition of storage cistern. (If water derived from well or pump, full details should be given.)

Clothes, washing. Describe apparatus provided and its condition.

House refuse. Number and condition of dustbins. Note any accumulation of refuse.

Animals, fowls, etc. Conditions under which they are kept. Name of owner.

Occupation. Particulars of how premises are let and occupied—in schedule form as follows :—

Name of Occupier.	Rooms Occupied.	No. of Occupants.				Rent Paid.	Remarks, *e.g.* Names of Tenants, Occupation followed, etc.
		Adults.		Children.			
		M.	F.	M.	F.		
Totals.							

Overcrowding. Note as to circumstances and condition of families concerned in rooms overcrowded.

Remarks . . . .

Recommendations. These may follow at this point, or may take the form of a specification to accompany this Report.

Standards of fitness. In the Manual on Unfit Houses issued by the Ministry of Health in 1919 the following standards are suggested—

A fit house should be—

(1) Free from serious dampness;
(2) satisfactorily lighted and ventilated;
(3) properly drained and provided with adequate sanitary conveniences, and with a sink and suitable arrangements for disposing of slop water; and
(4) in good general repair;

and should have—

(5) a satisfactory water supply;
(6) adequate washing accommodation;
(7) adequate facilities for preparing and cooking food; and
(8) a well-ventilated food store.

A useful standard of lighting is: Living-rooms should not be so dark in ordinary daylight as to hinder domestic work and to make it difficult to see whether the rooms are clean.

It is pointed out that minor defects may not cause more than inconvenience, but should, nevertheless, be put right; on the other hand, the cumulative effect of small defects may become serious. The definition of "sanitary defects" in the Housing Act, 1936 (p. 622) should also be noted.

Housing and health. It is difficult to assign to housing alone its proper share as a factor in the production of ill-health. People subjected to very poor housing conditions not infrequently suffer from other disabilities, such as unemployment with its consequent poverty, and belong to a class where good personal habits, maternal care, and cleanliness are only too often lacking.

Chalmers, late M.O.H. of Glasgow, always stressed the relationship of housing to high mortality. In Glasgow the tenement house is still common, and it has been shown that the expected years of life for males aged ten years in one-apartment houses are exceeded by 2·3, 5·56, and 6·13 years respectively in the case of males of the same age living in two, three, and four or more apartments. The differences are still greater in the case of females. In a paper on the association between mortality and density of housing Stocks concluded that the effects of overcrowding are most serious at pre-school ages. He pointed out that it is children of these ages that should benefit most from an improvement in housing conditions (*Proc. Roy. Soc.*

Med., July, 1934, pp. 1127–1146). Macgregor of Glasgow (Annual Report, 1926) has recorded that as the size of house increases the incidence of pulmonary tuberculosis diminishes—more noticeably in the case of females (see also p. 81). In a report on "Causal Factors in Tuberculosis" (Nat. Ass. Prev. Tub., 1933), Bradbury stated that on statistical grounds it was established that the greater incidence of tuberculosis in Jarrow than in Blaydon (the Tyneside areas studied) was associated with the greater overcrowding existing in Jarrow. In the M.R.C. Report No. 120, 1928, Halliday demonstrated that the incidence of measles in tenement dwellers was 3·7 times greater among children below school age (when case fatality is highest) than among children aged five to ten years. In housing scheme areas the incidence was only 0·4 as great. Opportunities for spread of infection are much more frequent in tenements with their common stairs and yards. It is interesting that the death rate from measles in Glasgow is three times higher for children under two years than in Birmingham, and twice as high for the age group two to five years. Graham Forbes in the M.R.C. Report No. 115, 1927, showed that in London the fourteen boroughs whose diphtheria incidence from 1916 to 1925 was above the London mean of 25·7 per 10,000, had an average population density of 109·3 persons per acre and a percentage of overcrowding of 21, whereas in the remaining boroughs with a diphtheria incidence below the mean the density averaged 70·2 persons per acre and the overcrowding 11·5 per cent. (*i.e.* persons living more than two to a room). Some possible relationship between overcrowding and high infant mortality is suggested by McKinlay in the Ministry of Health Report No. 55, 1929. It has frequently been stated that children living in damp houses are specially prone to suffer from acute rheumatism. In the Medical Research Council Report No. 114, 1927, on "Social Conditions and Acute Rheumatism," it was shown, however, that although a higher proportion of rheumatic families than of controls lived in damp houses, the difference was not thought to be significant.

The relationship between housing conditions and respiratory disease was discussed in the Medical Research Council's Report No. 192, 1934. The inhabitants of two areas, one in a poor-class quarter and the other in a re-housing scheme, each of which contained a population of roughly 1,000 persons, were observed by means of weekly house-to-house visits from September, 1928, to September, 1929. The results showed that there was a greater morbidity from respiratory disease in the re-housing area than in the slum quarter, but analysis of the data indicated that (1) there was less unemployment and somewhat better habits of diet in the poor-class quarter; (2) information was more easily collected and probably more accurate in the

re-housing area; (3) overcrowding, as judged by sleeping arrangements, was almost as common in the re-housing area as in the slum. The author concluded that one of the chief results of the inquiry was possibly to indicate the difficulties of field surveys undertaken to determine in a poor-class population the incidence of respiratory disease and its relation to environmental conditions.

It should be borne in mind that it may not be sound public health policy to remove people from a slum area to a modern housing estate if their means do not permit of their paying the necessarily increased rents and at the same time purchasing adequate food for the family. M'Gonigle has carried out some interesting inquiries into this problem (*Medical Officer*, 3rd June, 1933, p. 215; 10th June, 1933, p. 225).

A review by Britten of the relation between housing and health will be found in Reprint No. 1656 from the Public Health Reports, Vol. 49, No. 44, 2 November, 1934, of the U.S. Public Health Service.

SECTION X

PUBLIC HEALTH LAW (ENGLAND AND WALES)

N.B. Legislation within square brackets is supplementary to that contained in the main Acts.

THE PUBLIC HEALTH ACT, 1936 *

Part I. Local administration

Local authorities. 1 (Sect. 1). The following authorities are responsible for carrying this Act into execution—

(*a*) in a county borough, the council of the borough ;
(*b*) in an administrative county, as respects certain matters, the county council and, as respects all other matters, the councils of county districts.

" Local authority " means the council of a borough, urban district or rural district.

2 (Sect. 13). The Minister may by order declare any provisions of this Act, which are in force in boroughs and urban districts generally, to be in force in any particular rural district or in any particular contributory place in a rural district.

A " contributory place " has much the same meaning as " special purpose area " (see para. 8, p. 526).

3 (Sects. 2–5). The Minister may by order constitute a port health district and either make one local authority whose district forms part of the port the port health authority or else constitute a joint board, consisting of two or more riparian authorities, to be the port health authority. The order shall confer on the port health authority jurisdiction over all waters within the area to which the order relates and also over specified parts of such districts as may abut on the port.

The term " port sanitary authority " shall be replaced by the term " port health authority."

4 (Sect. 6). The Minister may by order constitute a united district consisting of such districts or parts of districts as in his opinion may with advantage be combined for any purpose of the Public Health Acts, and the governing body of such united district shall be a joint board consisting of representatives of the local authorities of the constituent districts.

5 (Sect. 8). For the purpose of facilitating co-operation between councils of counties and of county boroughs in the

* Does not apply to London.

discharge of their functions under this Act, the Minister may, with the consent of any two or more such councils, provide by order for the joint discharge of any of those functions through a joint board.

6 (Sect. 10). A port health authority or a joint board shall have the same powers of borrowing money for the carrying out of their functions as a local authority.

7 (Sects. 320–322). (*a*) The council of a county district may at any time by agreement transfer to the county council any of their functions under this Act either for a specified time or pending the rescission or variation of the agreement.

(*b*) On the complaint of a county council, or on complaint otherwise received, that a district council, port health authority or joint board have failed to discharge any of their functions under this Act, the Minister may hold a local inquiry and may thereafter make an order directing the defaulting authority to carry out their duties within a specified time. If the authority fail to comply the Minister may make another order transferring specified functions of the defaulting authority either to the county council or to himself. Expenses are recoverable from the defaulting authority.

8 (Sect. 12). With the approval of the Minister a rural authority may constitute any part of their district a *special purpose area* for the purpose of charging thereon exclusively the expenses of works of sewerage or water supply.

Part II. Sanitation and buildings

"Drain" means a drain used for the drainage of one building or of any buildings or yards appurtenant to buildings within the same curtilage.

"Sewer" does not include a drain as defined in this section, but, save as aforesaid, includes all sewers and drains used for the drainage of buildings and yards appurtenant to buildings. (Sect. 343.)

N.B. The effect of these definitions is far reaching and of great importance. It will be seen that in a strictly legal sense a "drain" is a pipe, or system of pipes, draining a single building, or buildings within a single curtilage or boundary. In other words, it serves only private purposes, and is, in fact, private property. In every case, therefore, a "drain" is constructed and maintained by the person or persons to whom it belongs.

A "sewer" is a very different thing. It is a pipe, or system of pipes, used for the drainage of any number of buildings more than one that are *not* within the same curtilage. It, therefore, serves a communal, as distinct from a private, purpose. In practice it is generally the pipe to which the "drains" of private premises are connected and into which they discharge. But the

term "sewer" is subject to further definition. A sewer may be either a "private sewer" or a "public sewer."

For full definition of the words "private sewer" reference should be made to Sects. 38 and 343. As defined in these sections a "private sewer" is a sewer constructed *after* 30th September, 1937, and used for the purpose of draining a particular group or block of buildings. It is a sewer because it serves more than one building but, being intended for the private use of particular buildings, it is private property and, similarly to a drain, it is constructed and maintained by the persons to whom it belongs. In practice a private sewer is generally laid in the gardens or yards of the particular premises it serves.

Sewers exactly similar to the above, but constructed before 1st October, 1937 (and then known as "combined drains"), are now "public sewers" vested in and maintainable by the L.A., but at the expense of the particular premises they serve.

"Public sewer" is defined in Sect. 20, and is, briefly, one which belongs to or is vested in a L.A. Public sewers (other than those that were formerly "combined drains" as described above) are public property, provided and maintained for public use by and at the expense of the public acting through the L.A. A typical example of such a sewer is one constructed under a public street for the purpose of draining the street itself, and into which the drains of individual properties are made to discharge.

Sewers and sewage disposal (Sects. 14–33). 1. Every L.A. must provide all necessary public sewers and arrange for dealing effectually with the contents of their sewers, and for these purposes are given the right, within their district, to carry out works in any street or land or to acquire by agreement any sewer or sewage disposal works.

2. If a L.A. desire to carry out works in a district other than their own they must advertise their proposals in a newspaper circulating in that district, and if any objections are made the Minister must hold a public inquiry.

3. A L.A. may at any time declare that any sewer or sewage disposal works serving their district and completed after the commencement of this Act shall as from a specified date become vested in them, and the owner of such sewer or disposal works may apply to the L.A. to make such a declaration. An aggrieved owner has the right of appeal to the Minister.

4. A L.A. may agree with any person proposing to construct a sewer that on some specified date they will declare the sewer to be vested in them. A similar agreement may be made in relation to a drain but it shall be a condition that the declaration shall not be made before the drain has become a sewer.

5. Where a person proposes to construct a drain or sewer the L.A. may, if they consider the drain or sewer is likely to be needed as part of a general sewerage system they propose to provide, prescribe the material or size of pipes, depth, fall, etc., of the drain or sewer and in such a case shall repay the person any extra expenses reasonably incurred by him in complying with their requirements. An aggrieved person has the right of appeal to the Minister.

6. No building may be erected over any sewer or drain shown on the map of sewers, which has to be kept by the L.A., without the consent of the authority.

7. No person shall discharge into any public sewer or into any drain or sewer communicating with a public sewer (*a*) any matter likely to injure the drain or sewer or to interfere with the free flow of its contents ; or (*b*) any chemical refuse or waste steam or any liquid at a temperature higher than 110° F. ; or (*c*) any petroleum spirit or carbide of calcium.

8. A L.A. may not use or construct any drain or sewer for the purpose of conveying foul water into any natural stream or watercourse, canal, pond or lake until the water has been purified.

The Public Health (Drainage of Trade Premises) Act, 1937, extends the provisions of the Public Health Act, 1936, with respect to the drainage of trade premises. It provides that the occupier of any trade premises may, with the consent of the local authority, discharge trade effluent into the public sewers. An occupier, who wishes to avail himself of this provision, must serve notice on the local authority stating the nature of the effluent and the quantity and rate of discharge, and the local authority may thereupon give consent, and may impose conditions as to the manner and place of discharge. Any person aggrieved by a decision of the local authority may appeal to the Minister of Health, whose decision is final.

The local authority may make bylaws with respect to the discharge of trade effluent, dealing with such matters as the period of the day in which the sewers may be used, the elimination of injurious matter from the effluent, the temperature of the effluent when discharged and the payment to be made by occupiers for the disposal of the effluent. An authorised officer of the local authority may enter premises to take samples of trade effluent.

The Model Bylaws (XXVIII., 1938) lay down a maximum permissible temperature for the effluent of 110° F. and suggest that the pH value of the effluent should fall between 7 and 10.

Private sewers and drains and cesspools (Sects. 34–42).
1. The owner or occupier of any premises is entitled to discharge

foul water and surface water into the public sewer, but, where separate public sewers are provided, foul water must be discharged into a foul water sewer and surface water only into a surface water sewer, unless the L.A. otherwise permit.

2. Before a person makes a communication between his drain and a public sewer he must give reasonable notice to any person directed by the L.A. to superintend the work. Within fourteen days after receipt of such notice the L.A. may notify the person that they intend themselves to make the communication. The L.A. need not do the work until the estimated cost has been paid to them.

3. The owner or occupier of any premises without the district of a L.A. has the right, subject to certain conditions, to discharge his drainage into the public sewers of that authority.

4. A L.A. shall reject the plans of a building or an extension of a building unless satisfactory provision for drainage is shown. A drain shall not be deemed satisfactory unless it connects with a sewer or discharges into a cesspool approved by the L.A. A L.A. shall not require connection with a sewer unless the sewer is within 100 feet of the building and is at a suitable level.

" Cesspool " includes a settlement tank or other tank for the reception or disposal of foul matter from buildings.

5. Where it appears to a L.A. that two or more buildings might be drained more advantageously in combination, the authority may, when the drains of the building are first laid, require that the buildings be drained in combination into the existing sewer by means of a private sewer to be constructed either by the owners or by the L.A. on behalf of the owners. In such a case the L.A. must fix the proportions in which the expenses of constructing and maintaining the private sewer are to be borne by the owners concerned and, where the existing sewer is 100 feet or more from the site of any of the buildings in question, the proportion which the L.A. themselves shall contribute. Such a sewer constructed by a L.A. shall not be deemed to be a public sewer by reason of the fact that some part of the expenses is borne by the L.A.

6. If a L.A. are satisfied (*a*) that satisfactory provision has not been, and ought to be, made for drainage of a building, or (*b*) that any cesspool, private sewer, drain, soil pipe, rainwater pipe, spout, sink or other necessary appliance either is insufficient or defective or is in such a condition as to be prejudicial to health or a nuisance, they shall by notice require the owner of the building to make satisfactory provision for drainage or require the owner or the occupier to do any necessary renewing, repairing or, as the case may be, cleansing of the cesspool, etc. (Sect. 39).

7. No rainwater pipe from a roof shall be used for the drainage of any sanitary convenience or sink. The soil pipe

of every water closet shall be properly ventilated. No surface water pipe shall be used as a ventilating shaft to any drain or sewer conveying foul water.

8. No person in an urban area may reconstruct or alter drains (or cover over work done in emergency) without giving the L.A. at least twenty-four hours' notice.

9. When a drain, though sufficient for the effectual drainage of the premises and communicating with a public sewer or a cesspool, is not adapted to the general sewerage system of the district or is in the opinion of the L.A. otherwise objectionable, the L.A. may close the existing drain and fill up the cesspool, if any, and do all necessary work at their own expense on condition that they first provide a drain effectual for the drainage of the premises.

Sanitary conveniences for buildings (Sects. 43–52). 1. A L.A. must reject the plans of a new building, or of an extension, if the plans do not show one or more water closets or earth closets unless the L.A. decide in any particular case to dispense with such provision. Unless a sufficient water supply and sewer are available, a L.A. shall not reject the plans on the ground that an earth closet is being provided. Any person aggrieved by a decision of a L.A. may appeal to a court of summary jurisdiction.

2. If a L.A. are satisfied (*a*) that any building is without sufficient closet accommodation or (*b*) that any closets provided are in such a state as to be prejudicial to health or a nuisance and *cannot without reconstruction* be made satisfactory, they shall by notice require the owner of the building to provide such closets or additional closets or substituted closets as may be deemed necessary, being in each case water closets or earth closets. Unless a sufficient water supply and sewer are available, the L.A. shall not require the provision of a water closet save in substitution for an existing water closet. The L.A. may themselves, by agreement or in default of the owner, do the work and recover the cost (Sect. 44).

3. If a L.A. are satisfied that any closet is in such a state as to be prejudicial to health or a nuisance and that it *can without reconstruction* be put into a satisfactory condition, they shall by notice require the owner or the occupier of the building to carry out any necessary works or cleansing. In default of the owner or by agreement the L.A. may execute any necessary works and recover expenses, and in those cases where works are not required a person failing to comply with a notice of the L.A. is liable to a penalty (Sect. 45).

4. In any urban area every workplace must be provided with sufficient and satisfactory separate sanitary accommodation for persons of each sex unless the L.A. in any particular case otherwise permit.

5. If a building has a sufficient water supply and sewer available, the L.A. may by notice to the owner require any closets, other than water closets, to be replaced by water closets notwithstanding that the existing closets are not insufficient in number and are not prejudicial to health or a nuisance. The notice may require either that the owner do the work or that the L.A. themselves be allowed to do it. The L.A. and the owner share the expenses equally.

A L.A. may pay to an owner a sum not exceeding one-half the cost of substituting a water closet for a closet of any other type even though no notice has been served by them.

6. Where a L.A. believe that a sanitary convenience, drain, etc., is prejudicial to health or a nuisance, or so defective as to admit subsoil water, they may examine it and apply any test other than a pressure test and, if necessary, open the ground. If no defect is found, the L.A. must make good any damage done by them (Sect. 48).

7. A room any part of which is immediately over a closet, other than a water closet or earth closet, or over a cesspool, midden or ashpit, shall not be occupied as a living-room, sleeping-room or workroom.

8. If any person allows the contents of a cesspool to soak therefrom or to overflow, the L.A. may by notice require him to execute any necessary works or to empty the cesspool periodically.

9. In the case of a sanitary convenience used in common by members of two or more families, a fine not exceeding 10*s*. shall be inflicted on any person improperly fouling or wilfully damaging or obstructing it. If the convenience, or the approach to it, gets into an insanitary state from lack of proper attention and the person responsible for this neglect cannot be ascertained, all persons having the use of the convenience shall be liable to a fine.

10. The occupier of a building must, in the case of a water closet, keep the flushing apparatus supplied with sufficient water and, where necessary, protected from frost, and, in the case of an earth closet, provide a supply of dry earth or other suitable deodorising material.

11. A L.A. may provide public sanitary conveniences and make bylaws for their regulation (Model Bylaws, XXVII., 1938). They may also require urinals to be attached to refreshment houses and places of public entertainment (Sects. 87–89).

"Sanitary conveniences" means closets and urinals.

"Water-closet" means a closet which has a separate fixed receptacle connected to a drainage system and separate provision for flushing from a supply of clean water either by the operation of mechanism or by automatic action.

"Earth closet" means a closet having a movable receptacle

for the reception of fæcal matter and its deodorisation by the use of earth, ashes or chemicals, or by other methods.

Buildings (Sects. 53–60). 1. A L.A. may reject altogether the plans of a building it is proposed to construct of materials specified in their bylaws as liable to rapid deterioration or may fix a period after which the building must be removed. This period may be extended from time to time by the L.A.

2. A L.A. shall reject the plans of a building it is proposed to erect on ground which has been filled up with, or on which has been deposited, fæcal or other offensive organic matter unless satisfied that the material has been removed or has become innocuous.

3. All new houses must be provided with satisfactory means of access for the removal of refuse and fæcal matter and, without the consent of the authority, no one may close or obstruct such means of access to an existing house.

4. The L.A. may by notice to the owner require any court, yard or passage appurtenant to a house to be asphalted or paved in such a way as to allow of satisfactory drainage of its surface or subsoil.

5. Save with the consent of the L.A., no entrance to any court on which two or more houses abut shall be closed or altered so as to impede the free circulation of air.

6. In the case of a dangerous or dilapidated building the L.A. may apply to a court of summary jurisdiction and the court may make an order either requiring the owner to execute any necessary works or to demolish the building or restricting its use.

7. Satisfactory entrances, exits and passages must be provided in all buildings such as theatres, halls, restaurants, shops, etc., to which the public are admitted, and means of escape from fire in the case of a building more than two storeys in height let in flats or used as a residential institution.

8. The " erection " of a building includes :—

(i.) the re-erection of any building or part of a building when an outer wall has been pulled or burnt down to within 10 feet of the surface of the ground adjoining the lowest storey of the building ;

(ii.) the re-erection of any frame building or part of a frame building which has been so far pulled or burnt down as to leave only the framework of the lowest storey of the building ;

(iii.) the roofing over of any open space between walls or buildings.

Bylaws regarding buildings and sanitation (Sects. 61–71). 1. Every L.A. may and, if required by the Minister, shall make bylaws regulating :—

(i.) as regards buildings—

(*a*) the construction of buildings and the materials used;

(*b*) the space about buildings, lighting and ventilation of buildings, and the dimensions of rooms intended for human habitation;

(*c*) the height of buildings and the height of chimneys above roofs;

(ii.) as regards works and fittings—

(*d*) sanitary conveniences; drainage and cesspools; ashpits; wells; cisterns;

(*e*) stoves and other fittings in relation to health and prevention of fire;

(*f*) communications between drains and sewers and between sewers.

Bylaws may also include provisions regarding:—

(*g*) the giving of notices and the deposit of plans, etc.;

(*h*) inspection of work, testing of drains and the taking of samples of building materials.

Bylaws regulating any of the matters mentioned in paragraphs (*a*), (*b*) or (*c*) of sub-section (i.) above may be made with respect to—

(*a*) structural alterations or extensions of buildings, and buildings so far as affected by alterations or extensions;

(*b*) buildings, or parts of buildings, in cases where any material change, within the meaning of this section, takes place in the purposes for which they are used.

Bylaws in respect of these matters may be made to apply to buildings erected before the date on which the bylaw in question came into force.

There shall be deemed to be "a material change in the purposes for which a building is used" if—

(*a*) a building, or part of a building, which was not originally constructed for occupation as a house, or which, though so constructed has been appropriated to other purposes, becomes used as a house; or

(*b*) a building, or part of a building, which was originally constructed for occupation as a house by one family only, becomes occupied by two or more families.

2. Where the L.A. consider that the operation of any building bylaw would be unreasonable in any particular case they may with the consent of the Minister relax its requirements or dispense with compliance therewith.

3. The L.A. may by notice require the removal or alteration

of work carried out not in conformity with their bylaws or executed notwithstanding rejection of plans.

4. Any building bylaw made by a L.A. shall cease to have effect after ten years, but the Minister may by order extend the period during which any such bylaw is to remain in force.

Under the P.H.A., 1875, and the Private Streets Works Act, 1892 (adoptive), a L.A. may carry out private street works, *i.e.* they may sewer, level, pave, light, etc., any street that has not been declared a highway repairable by the inhabitants at large. The expenses incurred must be apportioned among the frontagers and may be recovered summarily by the L.A. Once the work has been completed the L.A. may declare the street to be a highway—it then vests in the L.A. and its maintenance becomes a charge on all the ratepayers of the area. Under the P.H.A., 1875, every urban L.A. may make bylaws with respect to the level, width, and construction of new streets.

Model Bylaws (IV., 1939). Buildings

(This series takes the place of three previous series—urban, rural and intermediate. Bylaws founded on this model are made to meet local conditions by a process of omission or selection from the model.)

Exemptions. These bylaws do not apply to the following groups of buildings :—

(1) Buildings exempted by the P.H.A., 1936—
- (*a*) Buildings constructed to the approval of the Board of Education—schools, etc.
- (*b*) Buildings constructed by a C.C. or a L.A. to the approval of the Min. of Ag. and Fish.—farm buildings, dairies, etc.
- (*c*) Buildings, other than houses, constructed by statutory undertakers—railways, water, gas and electricity works.

(2) Buildings exempted by the bylaws :—
- (*a*) Outbuildings situated not less than 10 feet from an unexempted building and not fitted with apparatus for the combustion of fuel.
- (*b*) Mine buildings (except dwelling-houses).
- (*c*) Movable dwellings to which Sect. 269 of the P.H.A., 1936, applies.
- (*d*) Hop and fruit pickers' dwellings.

Sites. The site of a building (other than a warehouse, etc.) must, where necessary, be effectually drained (subsoil drains, see p. 481) or covered with a layer of impervious material so as effectually to protect the building against dampness arising from the subsoil.

The surface enclosed by the external walls must be either properly asphalted or covered with cement concrete 6 inches thick.

Where necessary the site must be raised by the deposit of sound material properly consolidated.

Walls. Walls must be made of good incombustible material properly bonded, resting on proper footings. External walls must be at least $8\frac{1}{2}$ inches thick—more for high buildings. Party-walls must be carried up to the underside of the slates or other covering of the roof. The joint between wall and roof covering must be solidly bedded in cement or mortar. There must be no opening in a party-wall.

Every wall must be provided with a damp-proof course at a height not less than 6 inches above the level of the external ground, and below the level of the lowest timbers. Basement walls, the sides of which are in contact with the ground, must be either constructed as hollow walls or protected by additional (vertical) damp-proof courses (see Fig. 15, p. 516). Materials approved for damp-proof courses are:—two or more courses of slates or engineering (*e.g.* blue Staffordshire) bricks bonded and set in cement, lead, copper, asphalt or other bituminous material conforming to appropriate British Standard Specifications.

Floors. Every floor constructed of boards, or wood blocks laid directly upon concrete resting on the ground, must be so constructed as to protect the floor from dampness or dry-rot (see also Ventilation, *infra*).

Roofs. The roof of a building must be "weather-proof" and covered with tiles or other incombustible material. The latter provision does not apply to domestic buildings distant by not less than twice their height from other buildings. For these, therefore, thatch or wood shingles may be used.

Space about buildings. There must be at least 24 feet in front of any part of a domestic building—measured to the boundary of any land or premises opposite.

There must be in the rear of any domestic building an open space exclusively belonging thereto and of an aggregate extent of not less than 150 square feet of space. In no part must the distance from the house to the boundary wall at the back be less than 15 feet for buildings not more than 25 feet in height, 20 feet for buildings over 25 but not more than 35 feet and 25 feet for buildings over 35 but not more than 50 feet. If the height of the building exceeds 50 feet the distance across the space must be equal to not less than half the height of the building. This space must be free from any erection above ground save a water-closet, earth-closet or privy.

Ventilation. (1) In every habitable room there must be at least one window, opening directly into the external air. The area of the window (or windows), clear of the frames, must

equal at least one-tenth of the floor area. One-half of the window must open, and the opening must extend to the top.

(2) Every habitable room without a fireplace and flue must have a special ventilating opening of at least 30 square inches (at least 50 in London) unobstructed area.

(3) Every room on the lowest storey of a domestic building having a boarded floor must have at least 3 inches clear space between this and the covering of the site. This space must be ventilated by air-bricks, etc. (not applicable when floor is laid directly on a dry and impervious foundation, *e.g.* a wood block floor).

(4) Every pantry or larder for storage of perishable food shall be either ventilated to the external air by an opening fitted with a fly-proof cover, or provided with means of mechanical ventilation.

(5) Every habitable room, not situated in the roof, must be at least 8 feet in height. If the room is in the roof it must be 8 feet in height over not less than one half the area of the room measured at a height 5 feet above the floor.

Drainage. The lowest storey (other than a cellar constructed so as to be impervious to water) must be at such a level as to allow of effectual drainage.

Drains intended for conveying sewage must be :—

(*a*) constructed of sound pipes of suitable material, *i.e.* glazed stoneware, cast iron or concrete,
(*b*) not less than 4 inches internal diameter,
(*c*) properly supported,
(*d*) laid to proper fall, and
(*e*) capable of withstanding a reasonable hydraulic, smoke or air test, under pressure.

No part of a drain may be laid under a building where any other mode of construction is practicable. Any part of a drain laid in or under a building must be—

(*a*) constructed of cast iron or other not less suitable material,
(*b*) laid in straight lines for the whole distance,
(*c*) provided with adequate means of access,
(*d*) if laid in the ground, and unless constructed of cast iron, surrounded with concrete 6 inches thick.

All inlets not intended for ventilation must be trapped.

Every branch drain must join any other drain obliquely and in the direction of the flow.

A drain for conveying sewage must have at least one ventilating pipe, which must be situated at the head of the drain and be carried full bore to such height that no foul gas can escape into the building. This shaft must be at least 3 inches in diameter, and protected at the top by a suitable wire cage. (For adequate ventilation it is necessary to have at least two

untrapped openings, one at each end of the drain. See also p. 481.)

No inlet to any drain must be within the building except such inlet as may be necessary from a water-closet, bath, sink, urinal, bidet or lavatory.*

A soil-pipe must be at least 3 inches in diameter and carried up full bore as described for ventilating pipes. There must be no trap at its point of juncture with the drain.

A waste pipe for a bath, sink, bidet or lavatory basin, which discharges into a trapped gully, must, if it is more than 6 feet in length, be provided with a suitable trap.

A waste pipe which discharges into a soil-pipe must, whatever its length, be provided with a suitable trap adequately secured against destruction of the water seal.*

Water-closets. In a domestic building a water-closet apartment, not entered directly from the external air, must either have at least one external wall with a window not less than 2 square feet opening into the external air, or be sufficiently ventilated by mechanical means and be sufficiently lighted.

Suitable flushing apparatus must be provided. No part of the water-closet apparatus other than the flushing apparatus may be directly connected with any distributing pipe. The closet pan must retain a sufficient quantity of water, and be so made that filth will fall clear of the sides and directly into the water. It must be kept clean. Containers and D traps are not allowed.

If a water-closet is constructed to discharge into a soil-pipe which also receives the discharge from any other water-closet or from a bath, sink or lavatory, the trap of the water-closet must be ventilated by a pipe 2 inches in diameter, having an open end as high as the top of the soil-pipe or joined to the soil-pipe above the highest connection.

Earth-closets must be constructed so that they can be entered only from the external air, they must be at least 40 feet from any well, spring or stream the water from which is likely to be used for domestic purposes or for the preparation of food. Sufficient means of lighting and ventilation into the open air must be provided, also a suitable vessel of adequate capacity for dry earth or other deodorising substance, together with sufficient means for its application. The floor must be non-absorbent, 3 inches above the ground adjoining, and must have a fall to the door. There must be no connection with any drain. The receptacle for filth must be protected from rain, easily accessible, water-tight and non-absorbent. It must have a capacity of not more than 2 cubic feet (necessitating a weekly removal).

* These clauses constitute approval of the "one-pipe" system (see p. 481).

Ashpits. There is little need to construct these to-day, but where a fixed ashpit is constructed in connection with a building it must not exceed 20 cubic feet in capacity (*i.e.* not more than one month's storage) and must be at least 10 feet from a dwelling-house, 30 feet from any well, etc., accessible, and, if practicable, so situated that the contents are not carried through any dwelling-house. An ashpit must be properly roofed, ventilated, and provided with a close-fitting door. The walls must be at least 4 inches thick and rendered inside with cement or asphalt. The floor must be not less than 3 inches above the surface of adjoining ground.

Cesspools must be at least 50 feet from any dwelling-house or business premises and 60 feet (in London 100 feet) from any well, spring, etc. They must be so situated that they may be cleansed without removal of their contents through any dwelling, or public or commercial building. They must be impervious to liquid. If constructed of brickwork, they must be rendered inside with cement or properly asphalted, and if the soil is liable to be water-logged they must be backed with not less than 9 inches of well puddled clay. They must be arched over or otherwise properly covered, provided with means of access, and be properly ventilated.

Wells. A well intended for the supply of water for human consumption must be rendered impervious for a depth of not less than 6 feet, be protected from surface contamination by a water-tight paving at least 4 feet wide round the top and by a curb at least 6 inches high above the surface of the paving. Efficient covers (according to the means adopted for extracting water from the well), and means of access where necessary, must be provided.

Water tanks—*e.g.* for the storage of rainwater for human consumption, if they form a sole means of supply, must be of not less than 1,500 gallons' capacity. They must be water-tight and properly covered and ventilated. Any overflow pipe must be properly protected and any draw-off or suction pipe must be at least 3 inches from the bottom.

Stoves and other fittings. A gas fire fitted in a habitable room must be provided with an adequate flue.

Any geyser or similar gas-heated apparatus of the rapid water-heating type fixed in any room must be provided with an adequate flue fitted with a suitable baffle and discharging into the chimney flue belonging to the room in which the apparatus is fixed, or into the open air. The flue may discharge into an open space immediately below the roof if the space does not form part of a living-room and is adequately ventilated. A geyser may not be fitted in a room which is without a window made to open.

Giving of notice. A person who intends to erect a building

to which the bylaws apply must give notice in writing to the L.A. showing :—

(*a*) the nature of the building and whether it is intended wholly or in part as a dwelling-house ;

(*b*) the materials to be used ;

(*c*) the mode of drainage ; and

(*d*) the water supply.

The notice must be accompanied by plans in duplicate, drawn to scale on durable material, and signed by the person responsible. In addition, notice (not less than twenty-four hours) must be given of the date and time on which the work will be commenced.

Model Bylaws (IV.D, 1939). New Streets (made under Sect. 157, P.H.A., 1875).

A carriage road must be at least 36 feet wide if over 1,000 feet long ; other dimensions are laid down for shorter streets. If a street is less than 100 feet long and is not laid out as a carriage road, it must be at least 24 feet wide. Every new street must have an opening at one end as wide as the street.

Removal of refuse, scavenging, keeping of animals, etc. (Sects. 72–82.) 1. A L.A. may and, if required by the Minister shall, undertake the removal of house refuse and the cleansing of earth-closets, privies, ashpits or cesspools.

2. Power to make bylaws is given whether the L.A. undertake to perform these services or not.

3. The L.A. may remove trade refuse and shall make reasonable charges for so doing.

4. A L.A. who undertake the removal of house refuse may by notice require the owner or occupier of any building to provide such number of covered dustbins of such material, size and construction as the authority may approve.

5. A L.A. may provide all necessary appliances for the disposal of refuse. Only persons employed by a L.A. may sort over refuse deposited for removal or disposal. A L.A. may also, and if required by the Minister shall, undertake the cleansing of streets and may undertake street watering.

6. In an urban area the sanitary inspector may by notice served on the owner or occupier of premises call for removal within twenty-four hours of any accumulation of noxious matter. In default the sanitary inspector may have the accumulation removed and the L.A. may recover expenses.

7. An urban L.A. may by public or other notice call for the periodical removal of manure or refuse from mews, stables or other premises.

8. A L.A. may make bylaws (*a*) for prevention of nuisances from snow, filth, dust, ashes and rubbish and from the keeping

of animals, and (*b*) as to removal through streets of offensive matter or liquid.

Model Bylaws (I., I.A, II. and II.A, 1937) :—

1. (Where the local authority do not themselves undertake removal of refuse, etc.) The occupier of any premises must remove house refuse at least once a month and in so doing must avoid polluting any water likely to be used for domestic purposes or in the preparation of food or drink for human consumption ; he must cleanse all earth-closets at least once a week, privies and ashpits at least once a month and cesspools as often as may be necessary.

2. (Where the local authority undertake removal of refuse, etc.) After receipt of notice from the L.A. specifying the days on which and the hour at which they will remove house refuse from the premises, the occupier must put all house refuse in a dustbin in time for its collection and must place the dustbin in a position on the premises which will be conveniently accessible from the nearest street and not necessitate the removal of the refuse through a dwelling-house if other means of access are available. No liquid matter may be placed in the dustbin.

3. Privies, cesspools, etc., if situated within 20 yards of any street, dwelling, school, place of public resort or business premises, must be emptied only between 6 a.m. and 8.30 a.m. from March to October and between 7 a.m. and 9.30 a.m. from November to February.

4. Precautions must be taken to prevent any filth, rubbish, etc., from falling on a footway or carriageway and, if such fouling should occur, the place must be cleaned at once.

5. Fæcal or offensive or noxious matter or liquid, unless removed in a receptacle made of impervious material and covered with a close-fitting lid, must not be carried through any street save between 6 a.m. and 8.30 a.m. from 1st March, to 31st October or between 7 a.m. and 9.30 a.m. during the rest of the year. Any receptacle or vehicle used must be so covered as to prevent the escape of any such matter or liquid.

6. Collections of filth, rubbish, etc., emitting a stench must not be deposited, for purposes of subsequent removal, within 100 yards of any street, dwelling, etc., for longer than twenty-four hours. All such offensive collections must be covered with a sufficient layer of earth or ashes or so treated as to prevent, as far as practicable, the emission of stench. Filth from cesspools or privies may be disposed of within 100 yards of any street, dwelling, etc., provided it is, with all reasonable dispatch, ploughed or dug into the ground or covered with a sufficient layer of earth or ashes or otherwise treated so as to prevent, as far as practicable, the emission of stench.

7. Filth or rubbish emitting a stench must, when being carried through a street, be covered with lime or otherwise treated so as to prevent, as far as practicable, the emission of stench.

8. Swine must not be kept within 100 feet of a dwelling unless the pig-sty is kept in a clean and wholesome condition.

9. A person must not keep cattle or swine or deposit their dung in such a situation as to render liable to pollution any water likely to be used for domestic purposes or in the preparation of food or drink for human consumption.

10. Structures in which horses, cattle or swine are kept must be adequately drained and provided with suitable receptacles for filth. The bottom of the receptacle must not be below ground level, and the receptacle must have a suitable cover, must be emptied at least once a week and must be so constructed and maintained as to prevent escape of its contents. These provisions apply in a rural district only to a structure within 60 feet of a dwelling-house not being the dwelling-house of the occupier of the premises.

(Under the Foot and Mouth Disease (Disinfection of Road Vehicles) Order, 1941, any road vehicle which has been used for the carriage of swill or of any sack or other container which has been used for such purpose must be disinfected by being thoroughly washed with a 4 per cent. solution of sodium carbonate after use and before being used again for carrying feeding stuffs for animals or anything to be used for or about animals. An Amendment Order of 1942 exempts from these requirements specially treated swill in respect of which a certificate from the Minister or from the L.A. has been issued. "Swill" means any broken or waste foodstuffs including table or kitchen refuse, scraps or waste, containing any meat, bones, offal or portions thereof, or any other part of the carcase of an animal; "bones" includes ground green or raw bones.)

Filthy or verminous premises or articles and verminous persons (Sects. 83–86). 1. If a L.A. decide, on the certificate of the M.O.H. or the S.I., that any *premises* used for human habitation are in such a filthy or unwholesome condition as to be prejudicial to health or are verminous, the L.A. shall give notice to the owner or occupier requiring him to cleanse, disinfect or whitewash the premises, and in the case of verminous premises to remove wallpaper or other wall covering and to take such other steps as the L.A. deem necessary to destroy or remove vermin. There is a fine for non-compliance and the L.A. may themselves do the work and recover expenses.

A notice served in respect of verminous premises may require that the L.A. be allowed to employ gas for the destruc-

tion of vermin. Such a notice must be served both on the owner and occupier and the L.A. must bear all the cost and may provide temporary accommodation for any person compelled to leave the premises by reason of their operations. (See Hydrogen Cyanide (Fumigation) Act, 1937, and Hydrogen Cyanide (Fumigation of Buildings) Regulations, 1938, p. 227.)

2. Where a L.A. decide, on the certificate of the M.O.H. or the S.I., that any *article* in any premises is so filthy as to render its cleansing or destruction necessary in order to prevent injury, or danger of injury, to the health of any person in the premises, the L.A. shall cause the article to be cleansed or destroyed at their expense and, if necessary for that purpose, to be removed from the premises. Similar action may be taken by the L.A., on the certificate of the M.O.H. or S.I., in the case of any article which is verminous or likely to be verminous by reason of its having been used by, or having been in contact with, any verminous person.

3. Upon the application of any *person*, a L.A. or C.C. may take such measures as may be necessary to free him and his clothing from vermin.

A county council, on a report from the M.O.H., or a L.A., on a report from the M.O.H. or S.I., that a person or the clothing of any person is verminous may with the consent of the person remove him to a cleansing station and free him and his clothing from vermin. If the person does not consent, the C.C. or the L.A. may apply to a court of summary jurisdiction for an order authorising his removal to a cleansing station and his detention there till cleansed. The cleansing of females must be done only by a registered medical practitioner or by a woman duly authorised by the M.O.H.

Any consent needed for the purposes of this section may be given by the parent or guardian in the case of a person under the age of sixteen years.

No charge shall be made in respect of the cleansing of a person or his clothing.

4. A L.A. or a C.C. may provide such cleansing stations as may be necessary.

N.B. "Vermin" includes eggs, larvæ and pupæ.

The Scabies Order, 1941, made under the Defence (General) Regulations, 1939, enables a M.O.H., after appropriate notice in writing to the occupier, to inspect any premises in which he has reason to believe a verminous person resides, to require the examination and, if necessary, the cleansing or treatment of any such person, and the cleansing, treatment or destruction of any suspected article in the premises. (See also p. 195.)

Part III. Nuisances and offensive trades

Statutory nuisances (Sects. 91–110). 1. Every L.A. must cause their district to be inspected from time to time for the detection of statutory nuisances.

2. The following matters may be dealt with summarily as statutory nuisances :—

(*a*) any premises in such a state as to be prejudicial to health or a nuisance ;

(*b*) any animal kept in such a place or manner as to be prejudicial to health or a nuisance ;

(*c*) any accumulation or deposit which is prejudicial to health or a nuisance. (Under the Public Health (Coal Mine Refuse) Act, 1939, an accumulation or deposit of refuse from a coal mine of which there is reasonable cause to believe that spontaneous combustion is likely to occur shall be deemed to be an accumulation or deposit which is prejudicial to health or a nuisance.) It is a good defence for the defendant to prove that the accumulation or deposit has not been kept longer than necessary for the purposes of the business or manufacture, and that the best available means have been taken to prevent nuisance ;

(*d*) any dust or effluvia caused by any trade, business, manufacture or process and being prejudicial to the health of, or a nuisance to, the inhabitants of the neighbourhood. (It is a good defence, however, for the defendant to prove that the best practicable means have been taken for preventing, or counteracting the effect of, the dust or effluvia) ;

(*e*) any workplace, in which sufficient ventilation is not provided or maintained, or which is not kept clean and free from noxious or offensive effluvia, or which is so overcrowded while work is carried on as to be prejudicial to the health of those employed therein. (The provisions relating to ventilation shall not apply to a shop to which the Shops Act, 1934, applies.)

(*f*) any other matter declared by this Act to be a statutory nuisance. Such matters are :—

(1) any pond, pool, ditch, gutter or watercourse which is so foul or in such a state as to be prejudicial to health or a nuisance, and any part of a watercourse not ordinarily navigated by vessels employed in the carriage of goods by water which is so choked or silted up as to impede the proper flow of water and thereby to cause a nuisance or give rise to conditions prejudicial to health (Sect. 259) ;

(2) any tent, van, shed or similar structure used for human habitation which is in such a state or so overcrowded as to be prejudicial to the health of the inmates, or the use of which, by reason of the absence of proper sanitary accommodation or otherwise, gives rise, whether on the site or on other land, to a nuisance or to conditions prejudicial to health (see also p. 573); (proceedings may be taken against the occupier of the land as well as against the occupant of the tent, etc., and it is a good defence for the occupier to prove that he did not authorise the placing of the tent, etc., on the land) (Sect. 268);

(3) any well, tank, cistern or water butt used for the supply of water for domestic purposes which is so placed, constructed or kept as to render the water therein liable to contamination prejudicial to health (Sect. 141).

It is provided in Sects. 39, 44, 45 and 48, on pp. 529, 530 and 531, that when, in the opinion of the L.A., any cesspool, private sewer, drain, soilpipe, rainwater pipe, spout, sink or other necessary appliance is in such a condition, or any closet is in such a state, as to be prejudicial to health or a nuisance, the L.A. may serve a notice on the appropriate person requiring the execution of such work as may be necessary. They may also apply a test to any such sanitary convenience, drain, private sewer or cesspool. The term "statutory nuisance," however, is not used in these sections.

N.B. Ships and boats, other than those controlled by His Majesty's or any foreign Government, lying in any inland or coastal waters are subject to these provisions relating to nuisances. The officer in charge is regarded as the occupier.

The expression "prejudicial to health" means injurious, or likely to cause injury, to health.

"Workplace" includes any place, other than a factory or workshop, in which persons are employed otherwise than in domestic service (*e.g.* an office).

3. Where a L.A. are satisfied of the existence of a statutory nuisance, they must serve an **abatement notice** on the person by whose act, default or sufferance the nuisance arises or continues, or, if that person cannot be found, on the owner or occupier of the premises, requiring him to abate the nuisance and to execute all necessary works. If the nuisance is due to any defect of a structural character, the notice must be served on the owner of the premises. If the responsible person cannot be found and it is clear that the owner or occupier is not to blame, the L.A. may themselves abate the nuisance.

N.B. " Owner " means the person who receives, or would receive if the premises were let, the rackrent of the premises either on his own behalf or as agent for someone else.

" Rackrent " means a rent which is not less than two-thirds of the net rent at which the property might reasonably be expected to let from year to year.

4. If the person on whom the abatement notice has been served does not comply with the notice or if the nuisance is likely to recur, the L.A. must cause a complaint to be made to a justice of the peace who must issue a summons requiring the person to appear before a court of summary jurisdiction.

5. The court may make a **nuisance order** (*a*) requiring the defendant to abate the nuisance within a time specified in the order and to execute any necessary works ; or (*b*) prohibiting a recurrence of the nuisance.

If the nuisance renders a building unfit for human habitation, the nuisance order may prohibit the use of the building for that purpose until the court is satisfied that the building has been rendered fit. In the case of a tent, van or shed, the court may prohibit its use for human habitation at such places, or within such area, as may be specified in the order (Sect. 268).

If it appears to the court that the responsible person cannot be found, the nuisance order may be addressed to, and executed by, the L.A.

6. Any person not complying with a nuisance order is liable to a fine not exceeding five pounds and a further fine not exceeding forty shillings for each day on which the offence continues after conviction. The L.A. are also entitled to expenses.

7. Complaint of the existence of a statutory nuisance may be made to a justice by any person aggrieved by the nuisance.

8. If the L.A. are of opinion that summary proceedings would afford an inadequate remedy, they may take proceedings in the High Court.

Smoke nuisances (see also p. 414) are also statutory nuisances.

1. They are—
   (*a*) any installation for the combustion of fuel which is used for working engines by steam or in any manufacturing or trade process and which does not so far as practicable prevent the emission of smoke to the atmosphere ; and
   (*b*) any chimney (not being the chimney of a house) emitting smoke in such quantity as to be a nuisance.

N.B. A funnel of, or chimney on, any ship habitually used as a sea-going ship sending forth black smoke in such quantity as to be a nuisance shall be a statutory nuisance.

" Smoke " includes soot, ash, grit and gritty particles.

" Chimney " includes structures and openings of any kind from or through which smoke may be emitted.

2. Where in the opinion of an authorised officer of a L.A. a smoke nuisance exists, he shall as soon as practicable notify the occupier of the premises and, if necessary, confirm the notification in writing within twenty-four hours.

3. Proceedings in respect of a smoke nuisance follow precisely the same course as those in respect of other statutory nuisances. It is a good defence in respect of (*a*) that the installation embodies the best practicable means for preventing the emission of smoke and that it has been carefully attended to; and in respect of (*b*) that the defendant has used the best practicable means for preventing the nuisance.

4. It should be noted that the court may impose a fine not exceeding fifty pounds for failure to comply with an abatement notice and a fine not exceeding ten pounds, with a daily fine not exceeding five pounds for continuing the offence, for failure to comply with or for contravention of a nuisance order in relation to smoke.

5. A L.A. may, and if so required by the Minister shall, make bylaws regulating the emission of smoke of such colour, density or content as may be prescribed by the bylaws. Building bylaws may require the provision in new buildings, other than private houses, of such arrangements for heating and cooking as are calculated to prevent or reduce the emission of smoke.

6. A L.A., subject to regulations made by the Minister, may undertake research into problems relating to atmospheric pollution and may contribute towards the cost of similar researches undertaken by other bodies or persons.

7. Smelting and other metal works are exempt from these provisions regarding smoke nuisances and the Minister may by order extend this exemption to other industrial processes.

The **Model Bylaws** (XXV., 1937) prescribe that the emission of black smoke for more than two minutes in any period of thirty minutes from a chimney of any building other than a private house shall be deemed to be a smoke nuisance.

Alkali, etc., Works Regulation Act, 1906. Such works include sulphuric acid works, chemical manure works, gas liquor works, nitric acid works, sulphate of ammonia works, chlorine and muriatic acid works, sulphide works, etc. In such works not more than $\frac{1}{5}$ grain of HCl, and not more than the equivalent of 4 grains of SO_3, may be present per cubic foot of chimney gases. The P.H. (Smoke Abatement) Act, 1926, provides for the extension of the list of works and of the list of gases and fumes to be regarded as "noxious or offensive" and the Alkali, etc., Works Orders, 1928 to 1939, add to the former benzine works, cement production works, lead works, etc., and to the latter fumes from paraffin oil works, fumes containing

silicon, calcium or their compounds, fumes from cadmium and its compounds, etc. Provision is also made for preventing nuisance from the depositing or discharging of waste matters.

Offensive trades. 1. No person may, without the consent of the L.A., establish in an urban area any offensive trade, *i.e.* (*a*) the trade of blood boiler, blood drier, bone boiler, fat extractor, fat melter, fellmonger, glue maker, gut scraper, rag and bone dealer, size maker, soap boiler, tallow melter or tripe boiler; or (*b*) any other trade which the L.A. by order confirmed by the Minister declare to be an offensive trade in the urban area. Fine not exceeding fifty pounds, and a further fine not exceeding five pounds for each day of continuing offence after conviction.

A L.A. may specify in their consent a limited time during which the offensive trade may be carried on.

Any person aggrieved by a decision of the L.A. may appeal to a court of summary jurisdiction.

An order made by a L.A. in respect of (*b*) above may declare a trade to be an offensive trade if carried on in a specified part of the urban area.

2. A trade shall be deemed to be established not only when it is established in the first instance but also when—

(*a*) it is transferred or extended to other premises;
(*b*) it is resumed after being discontinued for more than eighteen months; or
(*c*) the buildings in which it is carried on are enlarged.

A change in ownership or occupation of the premises, or the rebuilding of the buildings in which it is carried on after they have been wholly or partially pulled or burnt down, without any extension of the area, shall not be deemed to be an establishment of the business.

3. An urban authority may make bylaws with respect to any offensive trade in order to prevent or diminish any noxious or injurious effects of the trade and every urban authority may, and if required by the Minister shall, make bylaws with respect to the trade of **fish frying** carried on in any streets or premises within their district. All such bylaws cease to have effect at the expiration of ten years.

N.B. Any order in force in any area declaring the trade of fish frying to be an offensive trade ceased to have effect three years from the date of the commencement of this Act.

Model Bylaws (XVI., 1939) have been issued regarding fish frying and offensive trades. They deal with—

1. Storage of materials in air-tight, non-absorbent receptacles.
2. Treatment of all effluvia so as to render them innocuous—

e.g. by discharge into the open air through a high chimney, or by passage through a fire or condensing apparatus.

3. Daily cleansing of all utensils, floors, etc.

4. Maintenance of floors, walls, etc., in good condition. (Walls should be made of impermeable material to a height of at least 6 feet.)

5. Hot limewashing of all internal surfaces above the floor two or four times yearly.

6. Fish frying. The room in which the stove is situated to be provided with adequate and permanent means of ventilation to the external air. The stove to be provided with side screens and a suitable hood connected with a flue having a good draught.

Part IV. Water supply

(Sects. 111–142.) 1. Every L.A. must ascertain from time to time the sufficiency and wholesomeness of the water supplies within their district and must see that so far as practicable every house has available within a reasonable distance a supply of wholesome water sufficient for domestic purposes. The L.A. may either provide a supply themselves or require the owner of the house to do so.

2. All public pumps, wells, cisterns, reservoirs, conduits and other works used for the free supply of water vest in and are under the control of the L.A. Any such works that are no longer required or that are supplying polluted water may be closed by the L.A.

3. A L.A. supplying water may charge a water rate and may demand payment of the rate from the owner instead of from the occupier in the case of a house or part of a house occupied as a separate tenement in respect of which the owner and not the occupier is rated.

4. A L.A. supplying water may make bylaws for preventing waste, undue consumption, misuse or contamination of the water.

5. When plans of a house are deposited with a L.A., the authority shall reject the plans unless (*a*) there is a satisfactory proposal for providing in, or within a reasonable distance of, the house a supply of wholesome water sufficient for the domestic purposes of the inmates, and (*b*) they are satisfied that the proposal can and will be carried into effect. In case of dispute the person concerned may appeal to a court of summary jurisdiction. The L.A. may prohibit the owner of a house from occupying it or permitting it to be occupied until they have granted him a certificate in respect of the water supply.

6. A L.A. may by notice require the owner of a house to provide within a specified time a wholesome and sufficient supply of water. In default of the owner the L.A. may themselves provide the supply and recover expenses from the owner

provided these do not exceed twenty pounds in respect of any one house. There is an appeal to the Minister on the grounds that (*a*) the supply is not required; (*b*) the time allowed is insufficient; (*c*) the L.A. ought themselves to provide the supply or render the existing supply wholesome; or (*d*) part of the expense should be borne by the L.A.

7. If any well or other source of water supply, not vested in a L.A., is in the opinion of the L.A. likely to be used for domestic purposes and is likely to be so polluted as to be prejudicial to health, the L.A. may apply to a court of summary jurisdiction for an order closing the well or limiting the purposes for which the water may be used.

8. Any well, tank, cistern or water butt used for the supply of water for domestic purposes which is so placed, constructed or kept as to render the water liable to contamination prejudicial to health is a statutory nuisance.

Rivers Pollution Prevention Act, 1876. Definitions:—
"Stream" includes the sea to such extent, and tidal waters to such point, as may, after local inquiry, and on sanitary grounds, be determined by order of the Min. of H.

"Solid matter" does not include suspended particles.

"Pollution" does not include innocuous discoloration.

1. No solid refuse likely to interfere with the flow or cause pollution may be discharged into a stream.

2. No solid or liquid sewage may be discharged into a stream. Where sewage was actually being discharged, or arrangements were being made so to discharge it, at the time of the passing of the Act, offence cannot be proved if every practicable means is being taken to purify the sewage. The L.A. do not need the consent of the Min. of H. before instituting proceedings in respect of solid refuse or sewage, and complaint of the nuisance may be made by one or more private individuals.

3. No polluting liquid from a factory or solid matter from a mine may be passed into a stream.

Proceedings may be taken by a L.A. only with the consent of the Min. of H. The Min. of H., on appeal, may order a defaulting L.A. to act. In a manufacturing district the Min. of H. may give consent to proceedings only when satisfied after inquiry that reasonably practicable means exist for rendering harmless such noxious fluids, etc., and that no material injury will be inflicted on the industry by the proceedings.

Part V. Prevention, notification and treatment of disease.

Power to make regulations (Sect. 143). 1. The Minister may make regulations, as respects the whole or any part of

England and Wales, (*a*) for the treatment of persons affected with any epidemic, endemic or infectious disease and for preventing the spread of such disease; (*b*) for preventing danger to public health from vessels or aircraft arriving at any place; (*c*) for preventing spread of infection by any vessel or aircraft leaving any place (with the object of giving effect to the terms of any international agreement).

2. Such regulations shall specify whether county councils, local authorities or port health authorities are to be the responsible authorities and may impose duties on customs officers and coastguards. Power of entry is given to these officers.

3. Penalties not exceeding one hundred pounds, and fifty pounds a day for continuing offence.

N.B. Regulations made with respect to any disease may apply, with or without modifications, to that disease any enactment (including any enactment in this Act) relating to the notification of disease or to notifiable diseases.

Notification (Sects. 144–147). "Notifiable disease" means any of the following diseases: Smallpox, cholera, diphtheria, membranous croup, erysipelas, scarlatina or scarlet fever, and typhus, typhoid, enteric or relapsing fevers. It includes also, as regards any particular district, any infectious disease which the L.A. have made notifiable.

1. When an inmate of any building used for human habitation, other than a fever hospital, is known to be suffering from a notifiable disease—

(*a*) the head of the family, or the nearest relative present and in attendance on the patient, or every person in charge of or in attendance on the patient, or the occupier of the building must at once send a notice to the M.O.H.;

(*b*) every medical practitioner attending or called to visit the patient must at once send to the M.O.H. a certificate stating the name and address of the patient and the disease from which the patient is suffering.

Penalty of forty shillings—provided that a person who is required to send a notice only in default of some other person shall not be liable to a fine if he satisfies the court that he had reasonable grounds for believing that the notice had been duly sent.

"Occupier" here includes a person having the control of the part of the building in which the patient is, and, in the case of a house let in lodgings, the person who receives the rents either on his own account or as agent of someone else.

2. A L.A. must provide forms of certificate free of charge to any medical practitioner practising in their district and must pay him two shillings and sixpence for every case notified in

his private practice and one shilling if the case occurs in his practice as medical officer of any public body or institution. (Under the Measles and Whooping Cough Regulations, 1940, a fee of one shilling is payable for every notification of either of these two diseases.)

3. Cases occurring in any buildings occupied by, or among any persons employed by, His Majesty's forces must be notified.

4. A L.A. may by order make any other infectious disease notifiable in their area, either temporarily or permanently. All the provisions of this Act relating to notifiable diseases apply to such a disease. Save in case of emergency such order shall have no effect till approved by the Minister. The order after approval must be advertised in a local newspaper and the L.A. must send a copy of it to every medical practitioner practising in their district. The order comes into operation not earlier than one week after the date of the advertisement.

In case of emergency the L.A. may make a temporary order and advertise it at once. The order comes into operation a week after advertisement. A copy of the L.A.'s resolution, declaring the nature of the emergency, must be sent to the Minister at once, and the order, unless approved by the Minister, ceases to be in force at the end of one month after it is made. The Minister may revoke it at any earlier date.

By order of the Min. of H., plague (1900), cerebro-spinal meningitis, acute poliomyelitis, tuberculosis (1912), ophthalmia neonatorum (1914), encephalitis lethargica (1918), malaria, dysentery (bacillary or amœbic), acute primary pneumonia, and acute influenzal pneumonia (1919), puerperal pyrexia (1926) and measles and whooping cough (1940) have been made notifiable to the M.O.H.

N.B. When the Minister makes regulations regarding epidemic disease he is able not only to require notification generally throughout England and Wales, but also to prescribe the steps necessary to be taken for treatment and control of the disease.

Malaria induced for therapeutic purposes is not notifiable, save in the case of a patient about to be discharged from an institution who is liable to suffer a relapse. (Public Health (Infectious Diseases) Regulations, 1927.)

Under the Food and Drugs Act, 1938, medical practitioners must notify to the M.O.H. any cases of food poisoning occurring in their practice.

Anthrax, glanders, farcy and rabies in animals must be notified to the M.O.H. by veterinary inspectors of the local authority under various orders issued by the Min. of Ag. and Fish. in 1938. Anthrax and various industrial poisonings

contracted in a factory must be notified to the Chief Inspector of Factories under the Factories Act (see p. 667). Under the Sanitary Officers (Outside London) Regs., 1935, a district M.O.H. must notify to the Minister and to the county M.O.H. any case of plague, cholera or smallpox.

The **P.H. (Tuberculosis) Regs., 1930,** consolidated all earlier regulations and provided for (1) the notification of all cases of tuberculosis within forty-eight hours by general practitioners or by school medical officers, and every week by medical officers of public assistance institutions and sanatoria ; (2) the keeping of a confidential register of notifications by medical officers of health, open to inspection only by specially authorised persons, and the quarterly revision of the register ; (3) the making of all necessary arrangements by county councils and county borough councils for the detection and prevention of spread of tuberculosis.

The regulations require that nothing should be done to subject notified persons to any restriction, prohibition or disability in respect of their means of livelihood on the ground that they are tuberculous. An exception is made in the case of tuberculous persons desiring to engage in or actually engaged in the milk trade. See P.H. (Prevention of Tuberculosis) Regs., 1925, p. 611.

Infected articles (Sect. 148). No person may give, lend, sell, transmit or expose, without previous disinfection, any clothing, bedding, rags or any other article liable to carry infection which he knows to have been exposed to infection from any notifiable disease.

(Sect. 152.) No article known to have been exposed to infection from a notifiable disease may be taken or sent to any laundry, public washhouse or cleaning establishment, unless it has been disinfected to the satisfaction of the M.O.H. or some other registered medical practitioner, or is sent to a laundry with proper precautions for the purpose of disinfection, with notice that it has been exposed to infection. The occupier of any building in which a person is suffering from a notifiable disease shall, if required by the local authority, furnish to them the address of any laundry or other place to which articles from the house have been, or will be, sent during the continuance of the disease for the purpose of being washed or cleaned.

(Sect. 153) *Home work.* If a case of notifiable disease occurs on any premises, then, whether the person suffering from the disease has been removed or not, the local authority may make an order forbidding any of the work specified below to be given out to any person living or working on those premises. Any order so made may be served on the occupier of any factory or any other place from which work is given out or on any

contractor employed by such occupier. The order may operate for a specified time or until the premises have been disinfected.

The work to which this section applies is the making, cleaning, washing, altering, ornamenting, finishing and repairing of wearing apparel and such other work as may be specified by order of the Minister.

(Sect. 154.) No rag or old clothes dealer may, from his shop or while he is collecting, sell or deliver, whether gratuitously or not, any article of food or drink to any person or any article whatsoever to a person under the age of fourteen years.

(Sect. 155.) A person who knows he is suffering from a notifiable disease may not use any book from a public or circulating library, nor may any person having such a book under his control allow it to be used by a person whom he knows to be suffering from a notifiable disease. If a book has been exposed to such infection it must not be returned to the library, but the facts must be notified to the local authority, who must disinfect or destroy the book.

(Sect. 156.) No person may place in a dustbin any matter which he knows to have been exposed to infection from a notifiable disease and which has not been disinfected. The local authority must give notice of the provisions of this section to the occupier of any house where a person is known to be suffering from a notifiable disease.

Infected persons, contacts and carriers (Sects. 148–149). A penalty may be inflicted on any person who, (*a*) knowing he is suffering from a notifiable disease, exposes other persons to the risk of infection by his presence or conduct in any street, public place, place of entertainment or assembly, club, hotel, inn or shop, or, having the care of a person whom he knows to be so suffering, permits him to expose others to the risk of infection in any such places, or (*b*) knowing he is suffering from a notifiable disease, engages in any trade, business or occupation which he cannot engage in without risk of spreading the disease.

(Sects. 159–160.) No person, knowing he is suffering from a notifiable disease, shall enter (or, having the care of a person whom he knows to be so suffering, shall permit him to enter) (*a*) any public conveyance used for the conveyance of persons at separate fares, or (*b*) any other public conveyance without first notifying the owner or driver that he is so suffering.

The owner, conductor or driver of a public conveyance used for the conveyance of passengers at separate fares shall not convey therein a person whom he knows to be suffering from a notifiable disease, and in the case of any other public conveyance the owner or driver may refuse to convey the person therein until he has been paid a sum sufficient to cover the cost of disinfection.

The M.O.H. must be notified by the person in charge of a public conveyance if any case of notifiable disease has been conveyed therein and the conveyance must be disinfected. The L.A. must undertake the disinfection on request and no charge shall be made except where the owner or driver has conveyed a person knowing he was suffering from a notifiable disease.

(Sects. 150–151.) If the M.O.H. notifies a person having the care of a child who is, or has been, suffering from, or has been exposed to infection of, a notifiable disease that the child is not to be sent to school, the child may not attend school until the M.O.H. certifies he may do so without undue risk of infecting others.

The person in charge of a school in which any scholar is suffering from a notifiable disease shall, if required by the L.A., furnish them with a complete list of the names and addresses of the scholars, not being boarders. A small payment must be made to the principal for such a list.

See p. 569 for certain provisions with regard to inmates of common lodging houses and p. 606 regarding milk workers.

P.H. (Smallpox Prevention) Regulations, 1917, authorise the M.O.H. to vaccinate or re-vaccinate without charge any contacts of a case of smallpox who consent to the operation.

Port Sanitary Regulations, 1933, give powers for dealing with patients and contacts on board ship (see p. 642).

P.H. (Infectious Diseases) Regulations, 1927. A L.A., on a report of their M.O.H., may by notice in writing to the head of the family require the destruction of lice on the person or clothing of every occupant of a building where a case of typhus fever or of relapsing fever has occurred—as well as destruction of lice in the building itself. All recent contacts of the case may also be segregated till freed from lice.

If the M.O.H. suspects that any person in his district, who is employed in any business concerned with the handling of food or drink for human consumption, is a **carrier** of enteric fever or of dysentery, he must report to his L.A. The L.A. may by written notice to the manager of the business certify that it is necessary for the M.O.H., or a medical officer acting on his behalf, to make a medical examination of such suspected person. The manager and all other persons concerned must give the M.O.H. all reasonable assistance. If, as a result of the examination, clinical or bacteriological or protozoological, or from any other evidence, the M.O.H. is satisfied that the suspected person is a carrier, he must report to his L.A. who may by written notice to the manager and the suspected person prohibit the employment of such person during a specified period in any business where food or drink is handled.

These **Regulations** also made notifiable malaria, dysentery, acute primary pneumonia and influenzal pneumonia ; notification of malaria is not required when the disease has been induced for therapeutic purposes in an institution, but at least four days before such a patient's discharge the medical superintendent must notify the case to the M.O.H. of the district in which the patient proposes to reside if the patient is liable to relapse.

The M.O.H. must make all inquiries necessary and take steps for preventing the spread of any of these diseases, and, if a medical practitioner is not in attendance on the patient, the M.O.H. must take all necessary steps to ascertain the nature of the case. The L.A. may provide or contract for the provision of medical assistance for any person suffering from any of these diseases.

The M.O.H. must send to the Min. of H. the names and addresses of all cases of malaria in his district believed to have been contracted in the United Kingdom, including notified cases of induced malaria.

Cases of malaria must be supplied with efficient mosquito netting, must have any necessary quinine treatment, and must be advised as to the prevention of spread of infection. If two or more cases of malaria have been contracted in any district the L.A. may be required to appoint a special malaria officer.

The L.A. may, with regard to actual cases of dysentery, typhoid fever, or paratyphoid fever, require in writing that until further notice—

(*a*) Such person shall discontinue any occupation connected with the preparation or handling of food or drink ;
(*b*) Suitable measures shall be taken with respect to cleansing, disinfection, disposal of excreta, destruction of flies, and prevention of contamination of food and drink.

Note that any person sustaining damage as a result of these regulations in relation to any matter as to which he is not himself in default may claim compensation from the L.A.

Infected houses (Sect. 157). Heavy penalties may be inflicted on (1) anyone who is concerned in the letting of, or has recently ceased to occupy, a house or part of a house and who knowingly makes a false answer to any question put to him by a person negotiating for the hire of the house as to whether there has been within the preceding six weeks in any part of the house a person suffering from a notifiable disease ; (2) anyone who lets a house or part of a house in which a person has, to his knowledge, been suffering from a notifiable disease without having the house and all available articles therein disinfected to the satisfaction of the M.O.H. or some other registered

medical practitioner; (3) the keeper of an hotel or inn who allows a room in which any person has, to his knowledge, been suffering from a notifiable disease to be occupied by any other person before the room and its contents have been disinfected to the satisfaction of the M.O.H. or some other registered medical practitioner.

(Sect. 158.) Heavy penalties may be inflicted on any person if he ceases to occupy a house or part of a house in which, to his knowledge, a person has within six weeks previously been suffering from a notifiable disease and either—

(*a*) fails to have the house and the articles therein disinfected to the satisfaction of the M.O.H. or some other registered medical practitioner; or

(*b*) fails to give the owner notice of the previous existence of the disease; or

(*c*) on being questioned by the owner as to whether there has been any such infection within the preceding six weeks, makes a false answer.

The L.A. must give notice of the provisions of this section to the owner and occupier of any house where a person is known to be suffering from a notifiable disease.

Dead bodies (Sects. 161–165 and 198). 1. The Minister, with the concurrence of a Secretary of State, may make regulations regarding the disposal of dead bodies otherwise than by burial or cremation, as to the length of time a body may be retained on any premises, or as regards embalming.

2. On the certificate of the M.O.H. that the retention of a body in any building would endanger the health of the inmates (or the occupants of any neighbouring building), a justice may order the body to be removed by, and at the cost of, the L.A. to a mortuary and, if necessary, buried within a specified time. The relatives of the deceased may comply with such an order by having the body cremated within the time limited by the order.

3. If the M.O.H. or some other medical practitioner certifies that, in order to prevent spread of infection, the body of a person who has died of a notifiable disease in a hospital should be taken direct to a mortuary or forthwith buried or cremated, it shall not be lawful for any person to remove the body from the hospital except for such a purpose.

4. Every person having control of premises in which is lying the body of a person who has died of a notifiable disease shall take all reasonable steps to prevent persons from coming unnecessarily into contact with the body.

5. It is unlawful to hold a wake over the body of a person who has died of a notifiable disease. In contravention, the occupier of the premises who permits any such wake and every person attending are liable to a fine.

6. A L.A. or a parish council may, and if required by the Minister shall, provide a mortuary and a post-mortem room and may make bylaws regarding their management.

A **Memorandum** and **Model Bylaws** (XV., 1938) relating to mortuaries and post-mortem rooms have been issued by the Ministry of Health. The former states :—

Bodies should be received at any hour ; a caretaker should be provided and a register should be kept showing full name of the deceased, sex, age, cause of death, address from which brought, name and address of person by whose order the body has been brought and date of the removal of the body for burial. A sufficient number of wooden shells should be kept, each with a complete lining of tinned copper. A shell should be disinfected after being used for the body of a person who has died of an infectious disease.

Burial Acts, 1853–1906, provided for the closing by order in Council of overfull churchyards and the discontinuance of burials therein, the establishment of burial boards, the provision and maintenance of burial grounds for single and combined parishes and the transference of the duties of the original burial boards to borough, urban district and parish councils. A L.A. may, and if required by the Minister must, provide a cemetery, may make bylaws and must make regulations regarding its management. No ground may be used for burial within 100 yards of a dwelling-house without the written consent of the owner and occupier. The cemetery must have walls or railings at least 8 feet high and must be properly drained. The Minister has power to make regulations for the protection of health and the maintenance of decency.

The regulations require :—

(*a*) At least 9 feet by 4 feet of ground for adults over twelve.

(*b*) At least 6 feet by 3 feet of ground for children under twelve.

(*c*) At least 1 foot between graves.

(*d*) No unwalled grave may be re-opened within fourteen years after the burial of an adult or eight years after the burial of a child under twelve, unless for the interment of another member of the same family, when at least 1 foot of earth must be left above the last coffin.

(*e*) No coffin in an unwalled grave may come within 4 feet of the surface (within 3 feet in the case of a child under twelve).

The **Model Bylaws** (XIV., 1936, reprinted 1939) require that a coffin must not come within 3 feet of the surface ; provided that, if the coffin is constructed of perishable material and the

soil is of a suitable and friable character, the depth of the coffin beneath the surface may be not less than 2 feet.

Cremation

The Cremation Act, 1902. 1. Any burial board, any local authority having the powers of a burial board and any local authority maintaining a cemetery may provide and maintain a crematorium.

2. Site and plans of any crematorium must be approved by the Min. of H., and the premises must be certified to the Secretary of State by the burial authority as complete in every way.

3. None to be constructed within 200 yards of a dwelling-house save with consent of owner and occupier, or within 50 yards of a public highway.

4. Regulations to be made by Secretary of State.

5. Penalties to be inflicted on persons who, by false representation, etc., endeavour to procure the burning of any body.

Regulations, 1930. 1. Premises to be open for inspection by officers duly appointed by the Secretary of State or the Min. of H.

2. Unlawful to cremate any unidentified remains, or the body of any one who has left written instructions to the contrary.

3. Formalities to be observed before cremation can take place :—

(*a*) Registration of death, except when coroner gives a certificate after an inquest.

(*b*) Application must be made, and statutory declaration signed, by an executor or nearest relative.

(*c*) Special certificate from practitioner in attendance confirmed by a certificate from a specially appointed medical referee or by a registered medical practitioner of not less than five years' standing. This confirmatory certificate is unnecessary if a *post-mortem* examination has been performed by a pathologist appointed by the cremation authority or an inquest has been held.

(*d*) The medical referee is responsible for seeing that everything is in order, and that cremation is not performed on a body which might later be required for medico-legal purposes. The medical referee must be a registered medical practitioner of not less than five years' standing. He is appointed by the Secretary of State, and may also hold office as coroner or medical officer of health.

4. A medical referee may, without further formalities, permit the cremation of the remains of a stillborn child, if it be certified to be stillborn by a medical practitioner after examination of the body. The stillbirth must have been duly registered.

Under the Anatomy (England and Wales) Order, 1940, the time within which the certificate of interment of any body which has been subjected to anatomical examination shall be transmitted to the inspector of a district is limited to two years after the day on which the body has been received.

Disinfection of premises and articles (Sects. 166–168). 1. A L.A. may provide a disinfecting station and may disinfect there any articles free of charge.

2. If a L.A. are satisfied, on a certificate of the M.O.H., that the cleansing and disinfection of any premises and the disinfection or destruction of any articles therein would tend to prevent spread of any infectious disease, the L.A. shall notify the occupier that they will do what they regard as necessary unless he informs them within twenty-four hours that he will take within the time fixed such steps as are specified in the notice. In default, the L.A. may do the work themselves and recover expenses. Where the occupier is unable to take the necessary steps, the L.A. may with his consent do what is necessary at their own cost. Compensation may be paid by a L.A. to any person who suffers damage by their action. The owner of unoccupied premises is deemed to be the "occupier" for the purposes of this section.

3. A L.A. may provide temporary accommodation and remove to such accommodation, with his consent and on a certificate of the M.O.H., any occupant of a house which it is necessary to disinfect. Should such consent not be forthcoming, a justice's order may be applied for by the L.A.

Removal of infected persons to hospital (Sects. 169 and 170). 1. A justice may, with the consent of the superintending body of the hospital, order the removal to, and maintenance in, hospital on the application of the L.A. and at their cost of any person suffering from a notifiable disease (*a*) if his circumstances are such that proper precautions cannot be, or are not being, taken to prevent spread of infection and (*b*) that serious risk of infection is being caused to other persons. (See p. 560 for compulsory removal of tuberculous persons, p. 569 for compulsory removal of inmates of common lodging houses, and p. 648 for compulsory removal of persons on board ship.) Provision is also made for removal from canal boats, tents, vans, sheds and similar structures.

2. On the application of a L.A. a justice may order the detention in a fever hospital at the cost of the L.A. of any inmate of the hospital who is suffering from a notifiable disease and who has no lodging or accommodation to go to where proper precautions could be taken to prevent spread of the disease. A period of detention may be specified in the order

but any local justice may extend it. Any person who leaves a hospital contrary to such an order is liable to a fine not exceeding five pounds and the court may order him to be taken back to the hospital.

3. A C.C. or a L.A. may provide **ambulances** and make charges for their use. An ambulance used for the conveyance of a person suffering from an infectious disease may not be used again till disinfected or treated so as to prevent communication of the disease to any other person (Sect. 197).

Treatment of tuberculosis (Sects. 171–175). 1. The council of every county and county borough must make adequate arrangements for the treatment of persons suffering from tuberculosis in dispensaries, sanatoria and other institutions approved by the Minister. Without prejudice to this provision regarding institutional treatment, a C.C. or a L.A. may make such arrangements as they think desirable for the treatment of tuberculosis.

2. On the application of a C.C. or a L.A., a court of summary jurisdiction may, with the consent of the superintending body of an institution, order the removal to the institution and detention and maintenance therein for a period not exceeding three months of a person who is suffering from tuberculosis of the respiratory tract and is in an infectious state, provided (*a*) his circumstances are such that proper precautions cannot be, or are not being, taken to prevent spread of infection and (*b*) that serious risk of infection is being caused to other persons. The court may on application order further periods of detention but not exceeding three months on any one application.

Before making an application for an order the C.C. or the L.A. must give the patient or some person having the care of him at least three days' notice and on the hearing the court may require the patient to be examined by such medical practitioner as it may direct.

The C.C. or the L.A. may, and if so directed by the court shall, pay the whole or part of the cost of the removal and maintenance of the patient and make a contribution towards the maintenance of any of his dependants.

3. A county or county borough council may make arrangements for the after-care of persons who have suffered from tuberculosis.

4. The Minister may constitute an advisory committee to assist county and county borough councils in making arrangements for the treatment of tuberculous seamen.

5. The Minister may make regulations prescribing the qualifications of medical officers and health visitors for appointment in connection with tuberculosis *or venereal disease* and no person shall be appointed unless his qualifications are in accordance with the regulations (Sect. 180) (see p. 14).

The **P.H. (Venereal Diseases) Regulations, 1916,** and the **Venereal Disease Act, 1917,** are noted on pp. 95 and 96.

Regulation 33B, issued in 1942 under the Defence (General) Regulations, empowers the M.O.H. of a county or county borough to require the submission to examination and, if necessary, treatment of any person alleged by two separate persons to have been a source of infection. The duties of examination, treatment and certification under the Regulation can in general be discharged only by "special practitioners." "Special practitioner" means a registered medical practitioner who is in clinical charge of a treatment centre established by, or in receipt of a grant from, a local authority, for the diagnosis and treatment of venereal diseases, or who is a medical officer of any of His Majesty's forces employed for the time being as a specialist in venereal diseases, or who is for the time being designated by the Ministry of Home Affairs for Northern Ireland as a special practitioner for the purposes of this Regulation.

On receiving information suggesting that two or more patients have been infected by the same person, the M.O.H. may require such person (the "contact") to submit to medical examination by a special practitioner within a specified period and to furnish a certificate of compliance with the requirements. If the person is found free from venereal disease in a communicable form, the special practitioner should send to the M.O.H. a "clearance certificate" to that effect. If, however, further examination or treatment is necessary, it is the duty of the special practitioner to require the contact, by written notice, to attend and to follow his directions until certified free from venereal disease in a communicable form.

A breach of the Regulation is punishable by a maximum penalty of three months' imprisonment or a fine of £100 or both imprisonment and fine.

Prevention and treatment of blindness (Sect. 176). A C.C. or L.A. may make such arrangements as they think desirable for assisting in the prevention of blindness, and in particular for the treatment of persons ordinarily resident within their area who are suffering from any disease of, or injury to, the eyes.

For the purposes of this section, a person who becomes an inmate of any hospital or institution shall be deemed to continue to be ordinarily resident in the area in which he was ordinarily resident before he became an inmate of such hospital or institution.

The **Blind Persons Acts, 1920 and 1938,** define a blind person as one "so blind as to be unable to perform any work for which

eyesight is essential " and the same definition is given in the Old Age Pensions Act, 1938. The Education Act, 1921, defines blind as meaning " too blind to be able to read the ordinary school books used by children " (see p. 293). When the acuity of vision (refractive error being corrected) is below 3/60 Snellen, the person may usually be regarded as blind. (Min. of Health Circular 1353, 5 October, 1933, " Certification of Blindness.")

Old age pensions are provided for the blind at the age of forty, and L.A.'s (*i.e.* C.C.'s and C.B.C.'s) are required to keep registers of the blind within their areas. L.A.'s must put into operation schemes for the welfare of blind persons and schemes usually provide for :—

(*a*) Children under school age.
(*b*) Education and training of children, young persons and adults.
(*c*) Employment in workshops or by means of home-workers schemes.
(*d*) Hostels for blind workers.
(*e*) Homes.
(*f*) Unemployable blind.
(*g*) Home teaching.
(*h*) Registration.

L.A.'s usually delegate the actual work, or part of it, under these schemes to voluntary associations. (Min. of Health Circular 1621, 6th August, 1937 ; " Handbook on the Welfare of the Blind," Ministry of Health, 3rd edition, 1939 ; and *Public Health*, March, 1932, p. 178, Wray.)

COMPARATIVE TABLE OF REGISTERED BLIND PERSONS IN ENGLAND AND WALES, 1937 AND 1938.

Age group.	Year.				Increase or decrease.	Per-centage.
	1937.	Per-centage.	1938.	Per-centage.		
0–5	106	0·3	195	0·3	– 1	–0·5
5–16	1,728	2·5	1,676	2·3	– 52	–3·0
16–40	9,534	13·7	9,287	12·9	– 247	–2·6
40–50	7,263	10·5	7,278	10·1	+ 15	+0·2
50 & over	50,657	73·0	53,439	74·4	+2,782	+5·5
Totals .	69,378	100·0	71,875	100·0	+2,497	

(Annual Report of the Ministry of Health, 1938–39, p. 46.)

Miscellaneous (Sects. 177–179). 1. A L.A. may, with the approval of the Minister, provide a **temporary supply** of **medicine and medical assistance** for the poorer inhabitants of their district.

2. A C.C. or a L.A. may, with the consent of the Minister, contribute annually towards the support of any **association for providing nurses.**

3. A L.A. may provide **nurses** for attendance on patients suffering from any infectious disease where suitable hospital accommodation is not available or removal to hospital is likely to endanger the patient's health and may make charges for this service.

4. Subject to any conditions the Minister may by regulations prescribe, a C.C. or a L.A. may arrange for the **publication** within their area of **information on questions relating to health and disease,** and for the delivery of lectures and the display of pictures or films. (See p. 16.)

5. A C.C. or a L.A. may provide a **laboratory** for purposes connected with the diagnosis and treatment of diseases and for the making of such bacteriological, chemical and other examinations as may assist them in the performance of their functions under this Act (Sect. 196).

N.B. With the exception of anti-smallpox vaccination, unless a L.A. has a local Act, it is necessary to obtain the Minister's approval under Sect. 177 (1) before carrying out any form of artificial immunisation.

The Nurses' Registration Act, 1919, established a General Nursing Council which should keep a register of nurses and make rules for their training, examination and registration. The Council consists of 25 members—16 appointed by the nurses themselves, 2 by the Privy Council, 2 by the Board of Education and 5 by the Minister of Health. The rules, which are subject to the approval of the Minister, cover the arrangements for admission to and removal from the register and contain a complete syllabus of examinations. Any person aggrieved by the removal of his name from the register or by the refusal of the Council to approve a training institution may appeal to the Minister of Health.

The Nurses' Act, 1943, provides for the formation by the General Nursing Council of a Roll of Assistant Nurses and of an Assistant Nurses Committee of the Council to which representatives of assistant nurses must be elected. After a date to be fixed by the Minister it will be an offence for any person other than a State Registered nurse or a duly enrolled assistant nurse to take or use the title of "nurse" either alone or in combination with any other words or letters. An exception is made in the case of children's nurses, and power is given to the Minister to make regulations authorising the use of the word "nurse" by other classes of persons. The Act provides for the licensing of agencies and stipulates that they must supply only registered nurses, assistant nurses, certified mid-

wives or such other classes of persons as the Minister may prescribe, that they must inform the person to whom a nurse or midwife is being supplied of her qualifications, that the selection of the person to be supplied is made by or under the supervision of a registered nurse or registered medical practitioner, and that the agencies must keep such records as are prescribed by the Minister. Power is given to the General Nursing Council to make rules regarding the qualifications of teachers of nurses (sister tutors), and provision is made for trained nurses who might have applied (but did not do so) for registration as existing nurses or as nurses with intermediate qualifications during the period of grace given under the Nurses Registration Act, 1919. Application for admission to the list of such persons must be made to the General Nursing Council within two years of the passing of the Act.

The Cancer Act, 1939, requires every county and county borough council to provide adequate facilities for the treatment of persons suffering from cancer. The arrangements must be approved by the Minister and should include provision (*a*) for facilitating the diagnosis of cancer, (*b*) for the treatment of cancer in hospitals, either voluntary or municipal, and (*c*) for the payment, where necessary, of travelling expenses reasonably incurred by persons availing themselves of the services provided. In the preparation of their schemes councils must consult with committees representing the governing bodies and the medical and surgical staffs of local voluntary hospitals, and with representative local organisations of registered medical practitioners. Two or more councils, through a joint board or joint committee, may combine for the purpose of making such arrangements. Section 4 of the Act prohibits advertisements of offers to treat cancer and advertisements referring to articles in terms calculated to lead to their use in the treatment of cancer. There is a saving for advertisements sent to members of the medical, nursing and pharmaceutical professions, or published in journals of a technical character. Half the expenditure of the scheme is borne by the Exchequer, but, since the Exchequer grant is given according to the formula of the block grant, it varies greatly between one authority and another, with the poorest authorities getting most.

The period during which local authorities should submit their complete arrangements under the Act has been extended to 31st March, 1944.

Part VI. Hospitals

(Sects. 181–186.) 1. A C.C. or a L.A. may provide hospital accommodation for persons in their area who are sick—including clinics, dispensaries and out-patient departments and, in the

case of a council who are a maternity and child welfare authority, maternity homes.

2. A C.C. or a L.A. may subscribe to the funds of a voluntary institution a sum which does not in any year exceed the product of a rate of $1\frac{1}{3}$ pence in the pound or such higher rate as the Minister may approve.

3. When making provision for hospital (other than fever) accommodation, a C.C. or a L.A. must consult some body representative of the governing bodies and the medical and surgical staffs of the voluntary hospitals providing services in, or for the benefit of, their area.

4. A C.C. or a L.A. *may* recover the expense of maintenance in an institution of a patient receiving treatment for infectious disease and *must* recover the whole or part of the expense in the case of other patients—either from the patient himself, or from any person legally liable to maintain him, or from his estate if he has died. Such expenses are recoverable as a civil debt in proceedings commenced within twelve months of the patient's discharge or death.

N.B. "Expense of maintenance" is the sum representing the average daily cost per patient of the maintenance of the institution and its staff and the maintenance and treatment of the patients therein, and may include a reasonable charge for the patient's removal to or from the institution.

A C.C. or a L.A. may enter into an agreement to accept payment from some association or fund (*e.g.* The Hospitals Saving Association) in respect of its beneficiaries in lieu of recovering the whole or part of the expense of maintenance from the individuals ordinarily liable.

5. Any C.C. who have not prepared under the L.G.A., 1929, Sect. 63, a scheme for securing the proper isolation and treatment of persons suffering from infectious disease must make a survey of the isolation hospital accommodation within the county. On completion of the survey the C.C. must prepare a scheme in consultation with the county district councils and submit it to the Minister for his approval. If a C.C. fail to submit a scheme within six months after being required to do so, the Minister may himself prepare a scheme and put it into operation. The scheme may provide for the use of a hospital in one district by the inhabitants of another district and for the provision of new accommodation by the C.C. or a district council.

The expression "infectious disease" does not here include tuberculosis or venereal disease.

6. Within two years from the commencement of the Act the Minister by order dissolved every hospital committee constituted under the Isolation Hospitals Acts, 1893 and 1901, and transferred the property and liabilities of the committee either to a C.C., a L.A., or a joint board (Sect. 315).

Nursing homes (Sects. 187–195). 1. No person may carry on a nursing home without being registered with the local county or county borough council. An offence is punishable by a fine not exceeding fifty pounds and, in the case of a second or subsequent offence, imprisonment for a period up to three months may be inflicted in addition to a fine.

2. The council may refuse to register an applicant if they are satisfied :—

(*a*) that the applicant or any person employed by him at the home is not, by reason of age or otherwise, a fit person ;

(*b*) that, by reason of situation, construction, accommodation, staffing or equipment, the premises are unsuitable or that they are used for an undesirable purpose ;

(*c*) in the case of a nursing home not being a maternity home, that the home is not under the charge of a person who is either a registered medical practitioner or a qualified nurse and who is resident in the home or that there is not a proper proportion of qualified nurses employed ;

(*d*) in the case of a maternity home, that the person in superintendence of the nursing is not either a qualified nurse or a certified midwife, or that any person employed in attending any woman in the home in childbirth or in nursing any patient in the home is not either a registered medical practitioner, a certified midwife, a pupil midwife or a qualified nurse.

The certificate of registration must be kept affixed in a conspicuous place in the home.

3. The council may by order cancel a registration on any ground which would entitle them to refuse an application for registration or on the ground that the person concerned has been convicted of an offence under the part of the Act relating to nursing homes or that any other person has been convicted of such an offence in respect of the home under consideration.

Provided that, in the case of a nursing home which was in existence on 1 July, 1928, the registration shall not be cancelled on the ground that the provisions of paragraphs (*c*) or (*d*) above are not complied with unless, in the case of a nursing home, not being a maternity home, the nursing of the patients in the home is not under the superintendence of a qualified nurse who is resident in the home.

4. The council must give to the applicant or to the person registered at least fourteen days' notice before making an order refusing an application for registration or an order cancelling any registration and the person concerned is entitled to appear and show cause why the order should not be made. Any person aggrieved by an order may appeal to a court of summary jurisdiction.

5. A county council may, on application, delegate to a district

council any of their functions under the Act relating to nursing homes.

6. The council may make bylaws prescribing (*a*) the records of patients to be kept and, in the case of a maternity home, of any miscarriages occurring in the home and of the children born in the home and of the children born who are removed from the home otherwise than to the custody or care of any parent, guardian or relative; and (*b*) the notices to be given when any death occurs in a nursing home. (Model bylaws, Series XXIVA, 1938, have been issued.)

7. The M.O.H., or a qualified nurse or other authorised officer, may at all reasonable times enter and inspect the premises and the records, other than medical records.

8. The registration authority may exempt (with or without conditions) from the operation of the Act any hospital or institution not carried on for profit and the Minister may grant exemption to Christian Science nursing homes.

9. "Nursing home" means any premises used or intended to be used for the reception and nursing of persons suffering from any sickness, injury or infirmity and includes a maternity home but does not include—

(1) any hospital or other premises maintained or controlled by a Government department, county council or local authority or metropolitan borough council, or by any other body of persons constituted by special Act or incorporated by Royal Charter;

(2) any institution for persons of unsound mind within the meaning of the Lunacy and Mental Treatment Acts, 1890 to 1930;

(3) any certified institution within the meaning of the Mental Deficiency Acts, 1913 to 1927.

"Maternity home" means any premises used or intended to be used for the reception of pregnant women or of women immediately after childbirth.

"Qualified nurse" means a person registered in the general part of the register of nurses.

(See *Public Health*, March, 1929, pp. 187–195, Billham, Hewat and Winstanley; and June, 1934, pp. 294–298, Cassie.)

Part VII. Notification of births; maternity and child welfare and child life protection (see pp. 246 and 264).

Part VIII. Baths and washhouses

(Sects. 221–234.) A L.A. may provide public baths and washhouses and public swimming-baths and bathing places, and may make bylaws for their regulation. They may also make bylaws with respect to swimming-baths and bathing places, not under their own management, for securing the purity

of the water and the adequacy and cleanliness of the accommodation, for regulating the conduct of persons using such places and for the prevention of accidents.

N.B. Under the Physical Training and Recreation Act, 1937, C.C.'s are given power to provide swimming-baths.

The Model Bylaws (VIII.A, 1939) require, *inter alia*, that—

(1) The water admitted to the bath must be not less pure as judged by bacterial tests than the local public water supply.

(2) The water in a covered bath must be changed once at least in every four hours while the bath is in use, and once in every six hours in the case of an open bath.

(3) Where the water which is taken from the bath is returned to it the water must be purified by filtration, aeration and disinfection. If chlorination is used there must at all times be present in the water not less than 0·2 and not more than 0·5 part of chlorine per million. Such a bath must be emptied and cleansed at least once in every twelve months.

(4) Every bath must be provided with a sufficient number of shower-baths and of sanitary conveniences for persons of each sex, and of foot-baths or other facilities for washing. Towels and garments must be thoroughly cleansed after use.

(5) No person may enter a bath while knowingly suffering from any cutaneous, infectious or contagious disease.

Part IX. Common lodging houses

(Sects. 235–248.) 1. "Common lodging house" means a house (other than a public assistance institution) provided for the purpose of accommodating by night poor persons, not being members of the same family, who are allowed to occupy one common room for the purpose of sleeping or eating, and includes, where part only of a house is so used, the part so used.

2. The keeper must be registered with the L.A. who must keep a register in which shall be entered (*a*) the names and addresses of every registered keeper; (*b*) the situation of the common lodging house; (*c*) the number of lodgers permitted to be received; (*d*) the names and addresses of deputy keepers.

3. No applicant shall be registered until an officer of the L.A. has inspected the premises, and the L.A. may refuse registration (*a*) if the applicant or any person employed by him is not a fit person, whether by reason of age or otherwise; (*b*) if the premises are not suitable or are not suitably equipped as regards sanitation, water supply, means of escape from fire, etc.; or (*c*) if the use of the premises is likely to cause annoyance to local residents.

4. Registration shall remain in force for not more than thirteen months and may then be renewed from time to time for periods not exceeding thirteen months at any one time.

5. Every L.A. may, and if required by the Minister shall, make bylaws for fixing the number of lodgers and separation of sexes, for promoting cleanliness and ventilation, regarding precautions to be taken on the occurrence of infectious disease, and generally for the well-ordering of common lodging houses.

6. The keeper shall if required by the L.A. keep affixed and undefaced, on the outside of the house, a notice with the words "Registered Common Lodging-house." Either the keeper or his deputy must be continuously at the house between 9 p.m. and 6 a.m. The L.A. may require a keeper to report to them daily every lodger received during the preceding day or night. There is right of entry at all times for an authorised officer of the L.A.

7. The keeper must immediately notify every case of infectious disease to the M.O.H. and the relieving officer.

8. If a M.O.H. has reasonable grounds for believing that there is in a common lodging house a person who is suffering, or has recently suffered, from a notifiable disease, he may obtain a warrant from a justice authorising him to enter and examine any person in the house.

9. A L.A. may, with the consent of the superintendent of the hospital, order any lodger suffering from a notifiable disease to be removed to hospital and maintained there at their cost.

10. On the application of a L.A., a court of summary jurisdiction may order a common lodging house to be closed until it is certified by the M.O.H. to be free from infection.

11. A court may cancel the registration of a keeper convicted of an offence under this Act or the bylaws and may disqualify him for a stated period from being again registered.

Memorandum of Min. of H. outlines the following conditions as necessary for a common lodging house :—

1. House to possess kitchen and day-room apart from bedrooms.

2. If a constant water supply is not laid on, at least 10 gallons of water per head per day must be provided where there are water-closets and 5 gallons where there are dry-closets.

3. A separate closet should be allowed for every twenty registered lodgers.

4. Washing accommodation, where possible, should be in a special place, and there should be proper lavatory basins with taps and discharge pipes.

Model Bylaws (III., 1938). 1. In any room used as a sleeping apartment there must be 40 square feet of floor space for each person over ten years of age and 30 square feet for each person of an age not exceeding ten years. If the average height of the room is less than 8 feet the floor space per person must be increased in the proportion of one-eighth for every foot or part of a foot by which the average height falls short of 8 feet.

2. L.A. must specify the maximum number of lodgers for each room, and a notice showing the number allowed must be hung conspicuously in the room.

3. No person over ten to sleep in a room occupied by persons of the opposite sex.

4. Rooms may be reserved for married couples, but each bed must be effectually screened off.

5. Yards, etc., to be kept clean ; all floors to be swept daily before 10 a.m. and washed at least once weekly. All fittings to be kept clean.

6. All solid and liquid filth to be removed from rooms before 10 a.m. each day.

7. All closets and ashpits to be kept clean and in good order.

8. One window at least in every sleeping-room must be kept fully open for at least two hours each day save in bad weather or for some other sufficient cause.

9. Sufficient wash-basins and towels must be provided.

10. Bedclothes and bedding must be cleansed as often as necessary, and bedclothes must be removed as soon as possible after the bed has been vacated, and, with the bed, must be exposed to the air for two hours daily. No bed may be occupied within eight hours after being vacated, and no bed may be occupied by more than one male person over the age of ten.

11. In the event of a case of infectious disease occurring, the keeper of the common lodging house must take all necessary precautions and permit only the person in attendance on the patient to occupy the same room. He must comply with the instructions of the M.O.H. as to the disinfection of the room and its contents and must not permit the room to be used again till such disinfection has been completed.

12. Copies of the bylaws must be conspicuously placed in the house.

Part X. Canal Boats

(Sects. 249–258.) "Canal" includes any river, inland navigation or lake, and any other inland waters whether or not within the ebb or flow of the tide.

"Canal boat" means any vessel, however propelled, which is used for conveyance of goods along a canal but does not include a "Thames sailing barge," a registered sea-going ship or a vessel used for pleasure purposes only.

1. Registration authorities are the L.A.'s and port health authorities whose districts include, or abut on, some part of the canal.

2. A canal boat shall not be used as a dwelling (*a*) unless it is duly registered ; (*b*) for a greater number of persons of either sex or any particular age than is permitted by the certificate of registration,

3. The Minister must make regulations regarding registration, marking and numbering of canal boats, fixing the number, age and sex of dwellers on such boats, for promoting cleanliness, etc., and for preventing the spread of infectious disease.

4. The owner and the master must each have a copy of the certificate of registration.

5. A L.A. or port health authority may exercise, in relation to canal boats, all powers given them in this Act regarding infectious disease, including powers for removing persons to hospital. They may also detain the boat for cleansing and disinfection.

6. An inspector appointed by the Minister may enter a canal boat between 6 a.m. and 9 p.m., producing if required some duly authenticated document showing his right to enter, and may detain the boat for the purpose of his examination. An authorised officer of a L.A. has a similar right of entry if he has reason to believe that there is some contravention of the regulations or that there is on board any person suffering from infectious disease.

7. Proceedings in respect of an offence may be taken either where the offence was committed, or where the alleged offender for the time being is, or in the boat's registration area.

Regulations. 1. There must be one or more clean, dry cabins—after-cabin not less than 180 cubic feet, fore-cabin 80 cubic feet, of free air space, if used as dwellings.

2. Cabins must have sufficient sleeping accommodation and some means of ventilation other than the door. One cabin must contain a stove and chimney.

3. Storage for at least 3 gallons of water.

4. If the usual cargo is offensive, there must be a double water-tight bulkhead between an inhabited cabin and the hold, with an interspace of 4 inches open to the air and provided with a pump.

5. At least 60 cubic feet of space for every person over twelve years, and not less than 40 cubic feet below twelve. In "fly-boats" worked by shifts, cabins occupied at the same time by two persons over twelve must have a cubic capacity of at least 180 feet.

6. Males over fourteen and females over twelve must not sleep in a cabin with a married couple, nor may they share the same cabin unless married.

7. Master to notify any case of infectious disease—(1) to the L.A. of the district through which he is passing; (2) to the L.A. of the place of destination; and (3) to the owner, who in turn must notify the L.A. of the place to which the boat belongs.

8. After detention of the boat for disinfection, the master must be given a certificate by the L.A. that the boat is free from infection, and he cannot proceed till this is done.

9. The owner of a canal boat shall maintain it in the condition required for the purpose of registration and if he is convicted of default the court may order suspension or cancellation of the registration.

Part XI. Application of the Act to special premises

(Sects. 267–270.) The provisions of the Act apply, generally speaking, to ships and boats (other than Government vessels) lying in any inland or coastal waters as though they were houses, and to tents, vans, sheds and similar structures used for human habitation.

An occupier of land may not permit his land to be used as a site for **movable dwellings,** nor may any person keep a movable dwelling on any one site, or on two or more sites in succession within 100 yards of one another, for more than forty-two consecutive days or for more than sixty days in any twelve consecutive months unless he holds a licence from the L.A. If a movable dwelling is removed from the site on which it stands, but within forty-eight hours is brought back to the same site or to another site within 100 yards thereof, it shall be deemed not to have been removed at all for the purposes of reckoning any such period of forty-two consecutive days. The L.A. may attach to a licence such conditions as they think fit with respect to the number and classes of movable dwellings which may be kept on any site, the space between dwellings, water supply, and for securing sanitary conditions. Various movable dwellings are exempt such as those kept by a person on his own land for his own use and those forming part of a travelling circus or amusement fair. The Minister may grant a certificate of exemption to a camping organisation if he is satisfied that the camping sites used by its members are properly managed and kept in good sanitary condition and that the movable dwellings used by its members do not give rise to any nuisance.

"Movable dwelling" includes any hut, any van or other conveyance, whether on wheels or not, and any shed or similar structure, being a hut, conveyance or structure which is used either regularly or at certain seasons only, or intermittently, for human habitation. (*J. Roy. San. Inst.*, January, 1938, pp. 454–459, "Holiday Camps.") A L.A. may make bylaws for promoting cleanliness in, and the habitable condition of, tents, vans, sheds and similar structures used for human habitation, for preventing the spread of infectious disease by persons inhabiting such structures and generally for the prevention of nuisances in connection therewith (see also p. 544).

A L.A. may also make bylaws for securing the decent lodging and accommodation of hop-pickers and other persons

engaged temporarily in picking or lifting fruit, flowers, bulbs, roots or vegetables within their district.

The Camps Act, 1939, facilitates the construction, maintenance and management of camps of a permanent character.

Model bylaws regarding tents, vans, sheds, etc. (XVII., 1938). In addition to securing the cleanliness and habitable condition of tents, vans, sheds and similar structures used for human habitation, the bylaws contain provisions for preventing the spread of infectious disease (including puerperal pyrexia) :—

1. The occupier must adopt all reasonable precautions ordered by the M.O.H. for preventing the spread of the disease when an inmate of a tent, etc., is suffering from an infectious disease. A hut or van must be removed from one site to another if the M.O.H. so orders, and must not without the consent of the M.O.H. be moved from the site till disinfected.

2. There must be a sufficient supply of wholesome water in a clean, covered and accessible receptacle.

3. No animal may be kept and no filth deposited within 40 feet of any well, spring or other water likely to be used for domestic purposes.

4. A sufficient receptacle for refuse must be provided and no solid or liquid filth may be deposited, save in such receptacle, within 40 feet of the tent, etc.

5. The occupier of any land who allows any tent, etc., to be used on such land must provide in some suitable place and readily accessible a sufficient supply of wholesome water; and, if nuisance is likely to arise from lack of such convenience, provide and maintain privy accommodation, means for the disposal of waste water, or a covered receptacle for refuse. He must also see that each tent, etc., is separated from the next by at least 10 feet.

(See discussion, *J. Roy. San. Inst.*, June, 1928, p. 611.)

Model Bylaws regarding fruit and hop pickers, etc. (XX., 1938). Any person providing any lodging for persons engaged in the picking of hops, fruit or vegetables must comply with the following requirements :—

Give to the L.A. twenty-eight days' notice in writing of his intention to erect new lodging.

Give fourteen days' notice in writing of intention to re-occupy in any year after first year of usage.

Maintain lodging in clean, dry, weatherproof condition at all times when in use.

Lodging not to be used unless site reasonably free from damp.

New lodgings to be not less than 20 feet apart at front and not less than 15 feet apart elsewhere and no obstruction to interfere with access of air or light.

Minimum floor space of 20 square feet for each occupant, two children under ten years to be counted as one person ; sufficient means of lighting and ventilation.

Separation of the sexes.

Provide suitable accommodation for drying clothes and for cooking. One cooking-house for every sixteen persons.

Provide at all times a supply of good wholesome water for domestic purposes.

Provide clean, dry, suitable bedding.

Cause walls and ceilings to be cleansed or limewashed once in every year not more than two months before occupation.

Remove refuse daily from lodging and surrounding land.

Provide properly constructed water-closets, earth-closets or privies—separate for the sexes—not less than one for every twenty persons (including children) lodged.

Part XII. Certain general powers

1. (Sect. 275.) A L.A. may, by agreement with the owner or occupier of any premises, themselves execute any work which they have under this Act required him to execute.

2. (Sects. 290 and 291.) Subject to any right of appeal that may exist, if a person required by a L.A. to execute works fails to execute the works indicated within the specified time, the L.A. may themselves execute the works and recover reasonable expenses. Such expenses are a charge on the premises and a L.A. may by order declare the expenses to be payable with interest by instalments within a period not exceeding thirty years.

3. (Sect. 287.) Right of entry to premises at all reasonable times for the purposes of the Act is given to an authorised officer of a council on his producing, if so required, some duly authenticated document showing his authority. Admission to any premises other than a factory, workshop or workplace shall not be demanded unless twenty-four hours' notice of the intended entry has been given to the occupier. A warrant to enter premises may be obtained from a justice of the peace.

N.B. "Authorised officer" means an officer of a council authorised by them in writing to act in relation to certain matters. The medical officer of health, the surveyor and the sanitary inspector are, by virtue of their appointments, authorised officers for the purpose of matters within their respective provinces.

4. (Sects. 283–286.) All notices, orders and other documents required under this Act to be issued by a council must be in writing and signed by an officer of the council. A **document** is **served** either—

(*a*) by delivering it to the person ;

(*b*) by leaving it at, or sending it in a prepaid letter to, the person's usual or last known address ;

(c) by addressing it to the "owner" or "occupier" and affixing it to some conspicuous part of the premises if the premises are unoccupied and the person on whom the notice should be served cannot be ascertained.

5. (Sect. 278.) A L.A. shall make full **compensation** to any person who has sustained damage by reason of the exercise by the authority of their powers under this Act in relation to a matter as to which he has not himself been in default. Any dispute in this connection must be determined by arbitration, provided that, if the compensation claimed does not exceed fifty pounds, either party may apply to a court of summary jurisdiction to have the matter settled.

FOOD AND DRUGS ACT, 1938

Definitions

Sect. 64

"Local authority" means any borough and any urban or rural district council.

"Food and drugs authority" means any metropolitan borough council and county borough council, and the council of any non-county borough or urban district which had a population of 40,000 or upwards at the last published census; and as respects any other area, the county council. The Minister may direct that the county council be the Food and Drugs authority in any district of which the local authority were not the Food and Drugs authority before the commencement of this Act, provided the exclusion of the district from the county council's area would render that area inconvenient in size, shape or situation. The Minister may also direct that the council of any non-county borough or urban district with a population of 20,000 or upwards be the Food and Drugs authority in place of the county council.

Sect. 100

"Artificial cream" means an article of food which, though not cream, resembles cream and contains no ingredient which is not derived from milk except water or any substance which may lawfully be contained in an article sold as cream.

"Authorised officer" means an officer of the council authorised by them in writing, either generally or specially, and, for the purposes of the provisions of this Act relating to the taking of samples, includes a police constable so authorised:

Provided that—

(a) the medical officer of health and sanitary inspector of a council shall by virtue of their appointments

be deemed to be authorised officers for all the purposes of this Act;

(b) any member of the Royal College of Veterinary Surgeons employed by the council for the purpose of the inspection of food shall be deemed to be an authorised officer for the purpose of the examination and seizure of meat under the provisions of this Act relating to unsound food;

(c) no officer of a council other than the medical officer of health, a sanitary inspector or a member of the Royal College of Veterinary Surgeons employed as aforesaid shall be authorised to act in relation to the examination and seizure of meat.

"Butter" means the substance usually known as butter, made exclusively from milk with or without salt or other preservative, and with or without the addition of colouring matter.

"Cheese" means the substance usually known as cheese, containing no fat other than fat derived from milk.

"Cream" means that part of milk rich in fat which has been separated by skimming or otherwise.

"Dairy" includes any farm, cowshed, milk store, milk shop, or other premises from which milk is supplied on or for sale, or in which milk is kept or used for purposes of sale or of manufacture into butter, cheese, dried milk or condensed milk for sale, or in which vessels used for the sale of milk are kept, but does not include a shop from which milk is supplied only in the properly closed and unopened vessels in which it is delivered to the shop, or a shop or other place in which milk is sold for consumption on the premises only.

"Dairyman" includes an occupier of a dairy, a cowkeeper, and a purveyor of milk.

"Drug" includes medicine for internal or external use.

"Food" means any article used as food or drink for human consumption, other than drugs or water, and includes—

(a) any substance which is intended for use in the composition or preparation of food;

(b) any flavouring matter or condiment; and

(c) any colouring matter intended for use in food:

provided that, notwithstanding anything in this definition, the addition of any colouring or flavouring matter or condiment to an article used as food or drink shall be deemed to be the addition of a substance to food.

"Ice-cream" includes any similar commodity.

"Knacker's yard" means any premises used in connection with the business of slaughtering, flaying or cutting up animals, the flesh of which is not intended for human consumption.

"Margarine" means any food, whether mixed with butter or not, which resembles butter and is not milk-blended butter.

"Margarine-cheese" means any substance prepared in imitation of cheese and containing fat not derived from milk.

"Milk-blended butter" means any mixture produced by mixing or blending butter with milk.

"Purveyor," in relation to milk, includes any person who sells milk, whether wholesale or by retail.

"Sanitary convenience" means a closet, privy or urinal.

"Slaughter-house" means any premises used in connection with the business of slaughtering animals, the flesh of which is intended for sale for human consumption.

N.B. (*a*) Any reference to milk shall be construed as including a reference to cream and to separated milk, but not as including a reference to dried milk or to condensed milk; and (*b*) any reference to food of any kind sold, or offered, exposed, intended or in preparation, for sale for human consumption shall be construed as including a reference to that food sold, or offered, exposed, intended or in preparation, for sale for the manufacture of products for human consumption.

Part I. Composition of food and drugs (Sects. 1–7)

1. No person shall *add* or direct or permit to be added any substance to any food so as to render the food injurious to health or any substance to any drug so as to affect injuriously the quality or potency of the drug—with the intent that the food or drug may be sold in that state. No person shall sell or have in his possession for sale any food or drug to which any substance has been so added.

2. No person shall *abstract* or direct or permit to be abstracted from any food any constituent thereof so as to affect injuriously the nature, substance or quality of the food with intent that it may be sold in its altered state—without notice to the purchaser of the alteration, or in contravention of any regulations made under this Act.

3. No person shall sell to the prejudice of the purchaser any food or drug which is *not of the nature, or not of the substance, or not of the quality*, of the food or drug demanded. It is no defence to allege that the purchaser bought for analysis or examination and therefore was not prejudiced.

The following are defences available in proceedings under this Section :—

(*a*) That the substance that has been added has not rendered the food injurious to health or has not affected injuriously the quality or potency of the drug, *and* that the addition was not made fraudulently to increase the bulk, weight or measure, or to conceal the inferior quality of the food or drug, *and*, either (1) that the addition was required for the production or preparation of the food or drug as an article of commerce, or (2) that a label satisfying the requirements of the Acts regarding labelling was attached to, or printed on the wrapper or container of, the article.

Similar defences are available in the case of constituents abstracted from a food or drug.

(*b*) That a patent is in force in respect of the food or drug and that the specification of the patent was observed.

(*c*) That any extraneous matter present was an unavoidable consequence of the process of collection or preparation.

(*d*) That the article supplied was a proprietary medicine and was supplied in response to a demand for that medicine.

(*e*) That the strength of any diluted whisky, brandy, rum or gin was not lower than 35 degrees under proof.

N.B. Food must, of course, be sold in accordance with the provisions of any regulations made under this Act prescribing the composition of, and prohibiting or restricting the addition of any substance to, the food.

4. **Labels.** (*a*) A label, to afford a defence under the preceding section, must state explicitly what substance has been added to, or what constituent has been abstracted from, the food or drug, and must be of adequate size and have the notice of addition or abstraction distinctly and legibly printed and conspicuously visible.

Labels that have been used for years stating that an article is mixed are exempt from these provisions (Sect. 5 (2)).

(*b*) Anyone selling any food or drug to which is attached a misleading label or publishing an advertisement falsely describing any food or drug is guilty of an offence unless he can prove that he did not know, and could not with reasonable diligence have ascertained, that the label was misleading or that the advertisement contained a false description.

It is a defence for a person who is by business a publisher to show that he received the advertisement for publication in the ordinary course of business.

N.B. The foregoing provisions relating to the composition of food and drugs are administered by Food and Drugs authorities. The remaining provisions of Part I. are administered by local authorities.

In a Government White Paper issued November, 1943, important emergency powers are given to the Minister of Food regarding labelling. It is proposed that pre-packed articles of food will require to bear a label indicating the name and address of the packer, the common or usual name (if any) of the food, the minimum quantity of food contained in the package and the common or usual names (but not the proportions) of the ingredients of the food. Where it is claimed that foods contain vitamins and minerals the label must in future bear a quantitative disclosure of these active ingredients. It will be an offence to display a label which falsely describes any food, whereas hitherto a sale had to be made first; and it will be an offence to give a label or to publish an advertisement which falsely describes or is calculated to mislead not merely as to the nature, substance or quality of the food, but as to its nutritional or dietary value.

Regulations as to food (Sect. 8)

The Minister of Health may make regulations—

(*a*) for the prevention of danger to health from the importation, preparation, transport, storage, exposure for sale, and delivery of food intended for sale or sold for human consumption;

(*b*) requiring wrappers or containers to be labelled or marked in accordance with the regulations;

(*c*) prohibiting or restricting the addition of any substance to, and regulating generally the composition of, any food—with a view to preventing danger to health or loss of nutritional value.

Unsound food (Sects. 9–12)

1. No person may (*a*) sell, or offer or expose for sale, or have in his possession for the purpose of sale or of preparation for sale, or (*b*) deposit with, or consign to, any person for the purpose of sale or of preparation for sale, any food intended for, but unfit for, human consumption.

It is a defence under (*b*) that notice was given to the person with whom the food was deposited or to whom it was consigned, that it was not intended for human consumption or that, when the food was delivered or dispatched, it was not known and could not with reasonable diligence have been ascertained that the food was unfit for human consumption.

The penalty for an offence under this section is a fine not exceeding fifty pounds or imprisonment for a term not exceeding three months, or both fine and imprisonment.

2. An authorised officer may at all reasonable times examine any such food intended for human consumption and, if it appears to him to be unfit for human consumption, may seize it and

remove it in order to have it dealt with by a justice of the peace.

The officer must inform the person in whose possession the food was found of his intention to have it dealt with by a justice and the person is entitled to be heard by the justice and to call witnesses.

If a justice is satisfied that any food brought before him, whether seized under the provisions of this Act or not, is unfit for human consumption, he must condemn it and order it to be destroyed or so disposed of as to prevent it from being used for human consumption.

If a justice refuses to condemn any food which has been seized, the local authority must compensate the owner of the food for any depreciation in its value resulting from its seizure and removal.

3. These provisions relating to unsound food apply to any food which is intended for human consumption and include food offered as a prize in connection with any entertainment or given away for the purpose of advertisement or deposited in any premises for such purposes.

"Entertainment" includes any social gathering, amusement, exhibition, performance, game, sport or trial of skill.

4. If an authorised officer has reason to suspect that any vehicle or any container contains any food intended for sale for human consumption, or in the course of delivery after sale for human consumption, he may detain, and examine the contents of, the vehicle or the container, and if he finds any food which appears to be intended for, but unfit for, human consumption, he may deal with it under the foregoing provisions. Vehicles belonging to, and containers in the possession of, railway companies or licensed carriers of goods are exempt.

Precautions against contamination of food (Sects. 13–16)

1. The following provisions relate to rooms in which food intended for human consumption, *other than milk*, is prepared, sold, exposed for sale or deposited for sale or for preparation for sale :—

(*a*) No sanitary convenience, dustbin or ashpit may be within, or communicate directly with, the room, or be so placed that offensive odours therefrom can penetrate into the room.

(*b*) No cistern supplying water to the room may communicate directly with, or discharge directly into, a sanitary convenience, and there may not be within the room any outlet for the ventilation of a drain or, *except with the approval of the local authority*, an inlet into any drain conveying sewage or foul water.

(*c*) The walls, ceiling, floor, windows and doors must be kept in a proper state of repair.

(*d*) The walls, ceiling and doors must be painted, whitewashed or cleansed as often as may be necessary to keep them clean and the windows must be kept clean.

(*e*) The room may not be used as a sleeping place and, so far as may be necessary to prevent risk of infection or contamination of food in the room, no sleeping place adjoining the room may communicate therewith except through the open air or through an intervening ventilated space.

(*f*) Except in the case of an artificially refrigerated room, suitable and sufficient means of ventilation must be provided and suitable and sufficient ventilation must be maintained.

(*g*) No refuse or filth may be deposited or allowed to accumulate in the room except so far as may be necessary for the proper carrying on of the business, and the floor must be kept clean.

(*h*) Cleanliness must be observed by persons employed in the room, both in regard to the room and all articles, apparatus and utensils therein, and in regard to themselves and their clothing.

(*i*) Suitable washing basins and a sufficient supply of soap, clean towels and clean water, both hot and cold, must be provided in, or within reasonable distance of, the room for the use of persons employed therein. This provision does not apply in the case of rooms used for the sale or storage of food in suitable closed containers.

A fine not exceeding twenty pounds may be imposed for an offence under this section, together with a fine not exceeding five pounds a day for a continuing offence, and either the occupier or the owner is liable according to the nature of the offence. (Sect. 13.)

"Room" includes a shop or cellar or any part of a building, and a shed, store or outbuilding or any part thereof, and the foregoing provisions save paragraphs (*e*) and (*f*) apply, so far as applicable, in relation to a yard, forecourt or area as they apply in relation to a room.

2. **Registration of premises.** No premises may be used for—

(*a*) the sale, manufacture or storage of ice-cream intended for sale; or

(*b*) the preparation or manufacture of sausages or potted, pressed, pickled or preserved food intended for sale,

unless they are registered for that purpose with the local authority. (*N.B.* Cooked meat or fish is deemed to be "preserved.")

The local authority may refuse, or cancel, registration if they regard the premises as unsuitable and must give the

applicant for registration, or the occupier of the premises, as the case may be, at least seven days' notice of the place and time at which they propose to consider the matter. The person concerned may attend with his witnesses and is entitled to be heard. If registration is refused or cancelled the local authority must forthwith inform the applicant or the occupier, as the case may be, and, if so required, must give him a statement of the grounds on which their decision was based. A person aggrieved by the decision of a local authority may appeal to a court of summary jurisdiction. Any change in the occupation of such registered premises must be notified forthwith to the local authority.

These requirements do not apply in the case of premises used primarily as a club, hotel, inn or restaurant; in the case of premises used as a theatre, cinematograph theatre, music hall or concert hall registration is necessary only when the premises are used for the manufacture of ice-cream for sale.

(For ice-cream in relation to milk-borne disease, see p. 589.)

3. A local authority may make bylaws for securing sanitary and cleanly conditions in connection with the handling, wrapping and delivery of food sold or intended for sale for human consumption, and in connection with the sale or exposure for sale in the open air of food intended for human consumption.

4. The name and address of the dealer must be legibly and conspicuously displayed on every stall, or vehicle, or on every basket, pail, tray or other container used without a stall or vehicle, where ice-cream is offered for sale in a street or other place of public resort.

A local authority may, by resolution, apply this requirement to all, or any, kinds of food, except milk. They must notify the Minister of the passing or revocation of such a resolution and must take such steps as he may direct for giving publicity to the resolution.

Food poisoning (Sects. 17–18)

A medical practitioner must notify the medical officer of health of the district of any case of food poisoning occurring in his practice, stating the particulars of the food poisoning from which the patient is suspected to be suffering. A fee of two shillings and sixpence is payable.

If the medical officer of health of a district has reasonable ground for suspecting that any food of which he, or any other officer of the local authority of the district, has procured a sample under this Act is likely to cause food poisoning, he may by notice require that, until his investigations are completed, the food is not to be used for human consumption and is not to be removed except to some specified place.

If the medical officer is satisfied that the food is likely to cause food poisoning, he may deal with it under the unsound food sections of this Act.

Meat from knackers' yards (Sect. 19)

No person shall sell, or offer or expose for sale, for human consumption any part of an animal which has been slaughtered in a knacker's yard.

Part II. Milk, dairies and artificial cream

Milk and dairies (Sects. 20–26)

1. **Regulations.** The Minister may make regulations (in this Act referred to as "Milk and Dairies Regulations") for all or any of the following purposes :—

(*a*) requiring the registration of dairies and of persons carrying on, or proposing to carry on, the trade of a dairyman ;

(*b*) for the inspection of dairies, and of persons in or about dairies who have access to the milk or milk vessels ;

(*c*) with respect to the lighting, ventilation, cleansing, drainage, and water supply of dairies ;

(*d*) for securing the cleanliness of churns and other milk vessels and appliances ;

(*e*) prescribing the precautions to be taken for protecting milk against infection or contamination ;

(*f*) for preventing danger to health from the sale of infected, contaminated, or dirty milk, and in particular for prohibiting the supply or sale of milk suspected of being infected ;

(*g*) imposing obligations on dairymen and their employees in regard to cases of infectious illness ;

(*h*) regulating the cooling, conveyance, and distribution of milk ;

(*i*) with respect to the marking and sealing of churns and other vessels used for the conveyance of milk, the labelling of vessels in which milk is sold or offered or exposed for sale or delivered, and the display of the vendor's name and address on any stall, or any vehicle, from which milk is sold or delivered ;

(*j*) in cases where no express provision is made by this Act, prohibiting or restricting—

(i.) the addition of any substance to, or the abstraction of fat or any other constituent from, milk ;

(ii.) the sale of milk to which any such addition, or from which any such abstraction, has been made, or which has been otherwise artificially treated ;

(*k*) for preventing danger to health from the importation of milk.

In this subsection the expression "milk" means milk

intended for sale or sold for human consumption, or intended for manufacture into products for sale for human consumption.

Regulations made under this section may be general regulations or regulations limited to a specified area.

2. **Special designations.** (1) Milk and Dairies Regulations may contain provisions for all or any of the following purposes—

(*a*) prescribing, in relation to milk of any description, such designation (hereinafter referred to as a "special designation") as the Minister considers appropriate;

(*b*) providing, as respects any special designation, for the granting by the Minister, or by county councils or local authorities, of licences to producers and purveyors of milk authorising the use of that special designation;

(*c*) prescribing the periods for which, and the conditions (including conditions as to the payment of fees) subject to which, licences, or licences of any particular class, are to be so granted;

(*d*) providing for the suspension or revocation of a licence in the event of a breach of any condition subject to which it was granted; and

(*e*) entitling any person aggrieved by the refusal, suspension, or revocation of a licence by a county council or local authority to appeal to the Minister.

(2) No person shall, for the purpose of the sale or advertisement of any milk—

(*a*) use a special designation in any manner calculated to suggest that it refers to that milk, unless he holds a licence authorising the use of that designation in connection with that milk; or

(*b*) refer to that milk by any such description, not being a special designation, as is calculated falsely to suggest—

(i.) that there is in force a licence authorising the use of a special designation in connection with that milk; or

(ii.) that the milk is tested, approved or graded by any competent person; or

(iii.) that the cows from which the milk is derived are free from the infection of tuberculosis or of any other disease.

In London, Food and Drugs authorities and, elsewhere, councils of counties and county boroughs, enforce the provisions under (2) above; in a county district, however, the local authority enforce them in the case of persons who are not producers of milk.

3. **Registration of retail dairymen.** If it appears to an authority by whom dairymen are registered that the public health is, or is likely to be, endangered by any act or default

of a person who has applied to be, or is, registered as a *retail* purveyor of milk, being an act or default, committed whether within or without the district of the authority, in relation to the quality, storage or distribution of milk, they must serve on him a notice stating the place and time, not being less than seven days after the date of the service of the notice, at which they propose to take the matter into consideration, and informing him that he may attend before them, with any witnesses whom he desires to call, at the place and time mentioned to show cause why they should not, for reasons specified in the notice, refuse to register him as a *retail* purveyor of milk, or, as the case may be, cancel his registration as such, either generally or in respect of any specified premises.

If a person on whom a notice is served under the preceding subsection fails to show cause to the satisfaction of the authority, they may refuse to register him as a *retail* purveyor or, as the case may be, cancel his registration as such, and shall forthwith give notice to him of their decision in the matter, and shall, if so required by him within fourteen days of their decision, give to him within forty-eight hours a statement of the grounds on which it was based.

A person aggrieved by the decision of an authority may appeal to a court of summary jurisdiction.

The court before which a person registered as a *retail* purveyor of milk is convicted of an offence under any of the provisions of this Act relating to milk, or under any Milk and Dairies Regulations, may, in addition to any other penalty, cancel his registration as such.

In London the provisions of this section shall apply also in relation to dairymen who are not retail purveyors of milk as they apply in relation to dairymen who are such purveyors.

4. **Adulteration of milk.** (*a*) The Minister of Agriculture and Fisheries may make regulations for determining what deficiency in any of the normal constituents of milk, or what proportion of water, in a sample shall for the purposes of this Act raise a presumption, until the contrary is proved, that the article sampled is not genuine milk.

Regulations made under this section shall be laid before Parliament as soon as may be after they are made.

(*b*) No person shall—

(i.) add any water or colouring matter, or any dried or condensed milk, or liquid reconstituted therefrom, to milk intended for sale for human consumption; or

(ii) add any separated milk, or mixture of cream and separated milk, to unseparated milk intended for such sale; or

(iii.) sell, or offer or expose for sale, or have in his

possession for the purpose of sale, for human consumption any milk to which any addition has been made in contravention of the provisions of this subsection.

No person shall sell, or offer or expose for sale, under the designation of milk any liquid in the making of which any separated milk, or any dried or condensed milk, has been used.

The Food and Drugs authorities are responsible for enforcing the provisions of (*b*).

5. **Tuberculous milk.** No person shall—

(*a*) sell, or offer or expose for sale, for human consumption ; or

(*b*) use in the manufacture of products for sale for human consumption,

the milk of any cow which to his knowledge has given tuberculous milk, or is suffering from emaciation due to tuberculosis, or from tuberculosis of the udder or any of the following diseases of cows—acute mastitis, actinomycosis of the udder, suppuration of the udder, any infection of the udder or teats which is likely to convey disease, any comatose condition, any septic condition of the uterus, anthrax, foot and mouth disease and any other disease added by Milk and Dairies Regulations.

The council of every county and county borough enforce the provisions of this section.

6. **Milk depots.** Where the local authority of a district outside London are not a welfare authority for the purposes of Part VII. of the Public Health Act, 1936, they may, with the approval of the Minister, establish depots for the sale, at not less than cost price, of milk specially prepared for consumption by infants under two years of age, and for that purpose may purchase and prepare milk and provide any necessary plant.

Artificial cream (Sects. 27–29)

(1) No person shall sell, or offer or expose for sale, for human consumption under a description or designation including the word "cream" any substance purporting to be cream or artificial cream, unless—

(*a*) the substance is cream ; or

(*b*) where the substance is artificial cream, the word "cream" is immediately preceded by the word "artificial."

No person shall use any vessel for conveying artificial cream intended for sale for human consumption, or for containing artificial cream at any time when it is exposed for such sale, unless the words "artificial cream" are printed in large and legible letters of uniform size and conspicuously visible either on the vessel itself, or on a label securely attached thereto.

(2) Artificial cream shall not be manufactured, sold, or exposed or kept for sale for human consumption except on premises registered by the Food and Drugs authority :

Provided that registration under this section shall not be required in respect of—

(*a*) the manufacture of artificial cream by any person solely for his domestic purposes ; or

(*b*) the manufacture of artificial cream on any premises for use in the preparation on those premises of some other food ; or

(*c*) the sale, exposure or keeping for sale of artificial cream on any premises where it is supplied only in the properly closed and unopened vessels in which it is delivered to those premises.

Any change in the occupation of registered premises must be notified to the Food and Drugs authority.

Where any substance having the composition of cream or artificial cream is sold or exposed or kept for sale on registered premises, it shall be presumed to be artificial cream, unless the contrary is proved.

(3) Such of the provisions of this Part of this Act and of any Milk and Dairies Regulations as relate to cream, other than provisions relating to the registration of dairymen and dairies, shall, unless the regulations otherwise provide, apply in relation to artificial cream.

The provisions relating to artificial cream are enforced by the Food and Drugs authority.

Part III. Other kinds of food

Bread and flour (Sects. 30–31)

The Minister may make regulations (in this Act referred to as " Bread and Flour Regulations ") for all or any of the following purposes—

(*a*) prescribing the kinds of flour other than wheat flour and the other substances which may be used in the making of bread for sale ;

(*b*) prescribing the descriptions under which bread made of flour other than wheat flour may be sold, and the manner in which any such bread is to be marked ;

(*c*) prohibiting or restricting the addition of any substance, or the application of any treatment, to flour intended for sale or for use in the making of bread for sale ;

(*d*) prescribing the descriptions under which, and conditions subject to which, flour may be sold ; and

(*e*) for preventing danger to health from the importation, preparation, transport, storage, exposure for sale and delivery of bread or flour.

Regulations shall not be made for any of the purposes mentioned in (*a*) or (*c*) above unless they are expressed to be in the opinion of the Minister necessary or expedient for preventing danger to health or loss of nutritional value, or otherwise for protecting purchasers.

Margarine, margarine-cheese, butter and milk-blended butter (Sects. 32–36)

(1) Butter and margarine must not contain more than 16 per cent. of water, nor milk-blended butter more than 24 per cent. Margarine must not contain more than 10 per cent. of fat derived from milk.

Any label or advertisement suggesting that margarine contains butter must state the percentage of butter. No offence is committed unless the figure stated differs by more than two from the actual percentage.

(2) (*a*) Margarine, margarine-cheese and milk-blended butter must be sold as such (or consigned as such when forwarded by any public conveyance).

(*b*) Every container of margarine, margarine-cheese or milk-blended butter must be so marked on the top, bottom and sides in block letters not less than three-quarters of an inch long. Every parcel of these articles exposed for sale by retail must have attached to it a clearly visible label with the appropriate word printed in block letters not less than one and a half inches long. When sold retail these articles must be wrapped in a paper wrapper with the appropriate word printed on the outside in block letters not less than half an inch long, and no other printed matter may appear on the outside of the wrapper save in the case of milk-blended butter where an approved description of the article must be printed together with the percentage of water contained.

(*c*) Any names or descriptions used in relation to margarine or milk-blended butter must be approved by the Minister of Agriculture and Fisheries.

(3) Factories of, and premises used by wholesale dealers in, margarine, margarine-cheese or milk-blended butter and premises where butter is blended, reworked or subjected to any other treatment (butter factories), must be registered with the Food and Drugs authority. A butter factory must not form part of, or communicate otherwise than by a highway with, any of these other premises.

Any change in occupation of registered premises must be notified to the Food and Drugs authority and the authority must inform the Minister of Agriculture and Fisheries of any registration of premises and of any change in occupation.

(4) A register showing the quantity and destination of each consignment of margarine, margarine-cheese or milk-blended

butter must be kept by the occupier of every factory of, and by every wholesale dealer in, such articles.

(5) If any substance intended to be used for the adulteration of butter is found in a butter factory the occupier is guilty of an offence, and, if any oil or fat capable of being so used is found, it shall be presumed to be intended to be so used, unless the contrary is proved.

All these provisions relating to margarine, margarine-cheese, butter and milk-blended butter are enforced by the Food and Drugs authority.

Ice-cream (Sect. 37)

Every manufacturer of, or dealer in, ice-cream must, upon the occurrence of any milk-borne disease among the persons living or working in or about the premises in which the ice-cream is manufactured, stored or sold, forthwith notify the medical officer of health of the district.

If the medical officer of health of a district has reasonable grounds for suspecting that any ice-cream, or substance intended for use in the manufacture of ice-cream, is likely to cause any milk-borne disease, he may notify the person in charge that, until further notice, the ice-cream or such substance is not to be used for human consumption and is not to be removed except to some specified place. If on further investigation the medical officer of health is not satisfied that the ice-cream or such other substance may safely be used for human consumption he must cause it to be destroyed and he must also have destroyed any other ice-cream or such other substance then on the premises as to which he is not so satisfied.

Compensation must be paid by the local authority save in the case of ice-cream or other substance proved to be likely to cause any milk-borne disease or where the owner of the article has been guilty of some offence under this section (Sect. 37).

" Milk-borne disease " means enteric fever (including typhoid and paratyphoid fevers), dysentery, diphtheria, scarlet fever, acute inflammation of the throat, gastro-enteritis and undulant fever. The Minister of Health may by order declare any other disease to be a milk-borne disease for the purposes of this section.

(For registration of premises, see p. 581.)

Horseflesh (Sect. 38)

A legible notice must be conspicuously displayed on any stall, shop or other place where horseflesh is sold for human consumption stating that horseflesh is sold there.

No person may supply horseflesh for human consumption to a purchaser who has not asked for it or who has asked to be

supplied with some compound article of food not ordinarily made of horseflesh.

"Horseflesh" means the flesh of horses, asses and mules, and includes such flesh whether cooked or uncooked and whether alone or mixed with any other substance.

Shell-fish (Sect. 39)

A county council or a local authority may provide, within or without their county or district, or contribute towards the expense of providing, tanks or other apparatus for cleansing shell-fish and may make charges for their use.

Part IV. Restrictions on the importation of certain foods (Sects. 40–43)

It is an offence to import into the United Kingdom any margarine, margarine-cheese, milk-blended butter or any adulterated or impoverished milk or other food unless in containers properly marked with a suitable name or description, or contrary to the provisions of this Act or of any regulations made under this or any other Act. The Commissioners of Customs and Excise have the duty of taking samples from consignments of such imported food and of undertaking prosecutions for offences under this Part of the Act.

Part V. Markets, slaughter-houses and cold-air stores

Markets (Sects. 44–56)

An urban authority and, with the consent of the Minister, a rural authority may establish or acquire a market within their district and may make market bylaws.

Slaughter-houses and knackers' yards (Sects. 57–61)

1. *Licensing.* The occupier of a slaughter-house or knacker's yard must hold a licence in respect of his premises granted by the local authority. Licences or registrations in force before the commencement of this Act expired four months after the coming into operation of the Act.

Before granting a licence for the first time the local authority must have the premises inspected by one of their officers. They may not refuse to grant or renew a licence in respect of premises which, before the commencement of this Act, were registered or licensed without limit of time, unless they are satisfied that the applicant is not a proper person or that the premises are unsuitable—if, however, the premises can be made suitable the application for a licence must be adjourned for three months and the applicant served with a notice specifying the works which must be carried out within a reasonable time not being less than three months from the service of the notice.

If the local authority refuse to grant or renew a licence they must notify the applicant of their decision and must, if required by him within fourteen days of their decision, give him within forty-eight hours a statement of the grounds on which it was based. An aggrieved person may appeal to a court of summary jurisdiction.

Licences remain in force for such period not exceeding thirteen months as may be fixed by the local authority.

2. *Bylaws.* A local authority may make bylaws (*a*) for securing that slaughter-houses and knackers' yards are kept in a sanitary condition and are properly managed, and for preventing cruelty therein; and (*b*) requiring occupiers of knackers' yards to keep records of the animals brought into the yards and of the manner in which the animals were disposed of.

3. *Signs.* The words "Licensed slaughter-house" or "Licensed knacker's yard" must be displayed legibly and conspicuously on the premises.

4. *Public slaughter-houses.* A local authority may provide public slaughter-houses—if within the district of another local authority only with the consent of that authority, but such consent may not be unreasonably withheld. Any question whether or not consent is unreasonably withheld must be referred to and determined by the Minister.

A local authority by whom a public slaughter-house has been provided must make bylaws regarding its management, may make such charges for its use as the Minister has approved, and may provide plant for treating or disposing of waste matters.

5. *Eliminating private slaughter-houses.* (*a*) A local authority may acquire by agreement and discontinue the use of a slaughter-house; or may agree with any persons interested in any premises used as a slaughter-house for the discontinuance of slaughtering on those premises.

(*b*) A local authority who have provided a public slaughter-house may resolve that after a certain date no fresh licences will be granted by them and on that date all licences in force will cease to have effect and will not be renewable. Such a resolution must be published in one or more local newspapers and a copy served on all holders of licences; it must also be approved by the Minister, who must take into consideration any representations received by him within two months after publication of the resolution and must be satisfied that there will be slaughter-house accommodation adequate for the needs of the district. The resolution may exempt from its operation any specified existing slaughter-house.

The local authority must compensate the owner and occupier of any slaughter-house the use of which has had to be discontinued by reason of the resolution. If a slaughter-house

is structurally defective or otherwise open to objection on sanitary grounds, the arbitrator must have regard to that fact in determining the amount of compensation.

Memorandum regarding site and structure of slaughter-houses :—

1. Not within 100 feet of any dwelling ; direct communication with external air on two sides.
2. Cattle lairs not within 100 feet of any dwelling.
3. No part below the surface of adjoining ground.
4. Slope of entrance not more than 1 in 4, and never through a dwelling-house or shop.
5. No room or loft above.
6. Sufficient tank for water ; bottom at least 6 feet above floor.
7. Impermeable floor drained to a gully, properly trapped, and covered with a grating of bars not more than ⅜ inch apart.
8. Smooth impervious walls inside.
9. No closet, privy or cesspool to be within, or communicate directly with, a slaughter-house.
10. Lairs for animals to be properly paved, drained and ventilated.
11. No habitable room to be over any lair.

Model Bylaws (VI., 1937). 1. Every applicant for a licence to erect a slaughter-house must give full details as to site, structure, etc.

2. Every applicant for a licence to occupy must, in addition, give name and address of owner of premises, conditions of occupation and description of premises.

3. Once licensed, the person must apply in writing for registration of premises.

4. Ventilation and drainage to be maintained in good order.

5. Walls and floor to be kept clean, and washed within three hours of any slaughtering. The walls to be washed with hot lime between the 1st and 10th March, June, September and December.

6. No dogs or poultry to be kept in the slaughter-house. No animals to be admitted unless intended for slaughter for food. All animals to be kept in proper lairs, and no longer than absolutely necessary.

7. Skins, offal, etc., to be removed within twenty-four hours—storage in non-absorbent receptacles, which must be kept clean when not in use.

8. Sufficient water supply to be provided for cleansing.

Slaughter of Animals Act, 1933. This Act applies to England and Wales and is enforced by metropolitan borough councils, town councils, urban and rural district councils.

1. Animals must be stunned before slaughter by a

mechanically operated instrument, which is defined to include an electrical instrument.

Slaughter by a Jew, provided he is licensed by a commission established under the Act, or a Mohammedan for his co-religionists is exempt from this requirement.

2. The requirement as to stunning does not apply to sheep unless the L.A. apply it by resolution; goats can be excluded by resolution.

3. No animal may be slaughtered or stunned in a slaughter-house or knacker's yard by any person who is not the holder of a licence granted by a L.A. Licences may be granted only to persons over eighteen years of age who are considered by the L.A. to be fit to hold such licences. A L.A. may suspend or revoke a licence if the holder is considered unfit.

4. Persons engaged in slaughtering are required to house, feed, drive and fix animals in such a manner as to prevent unnecessary suffering prior to or during slaughter.

5. Penalties are provided for contravention of the provisions of the Act.

6. Local authorities who have provided slaughter-houses may employ licensed slaughtermen and make reasonable charges for their services.

7. Right of entry and power of inspection of slaughter-houses is given to the medical officer of health and sanitary inspector.

(Other provisions relating to slaughter-houses and slaughtering will be found in the P.H. (Meat) Regs., p. 599.)

Cold-air stores (Sect. 62)

A local authority who have provided, or are about to provide, a public slaughter-house or a market may, with the approval of the Minister, provide a cold-air store or refrigerator for the storage of meat and other articles of food and may make charges for its use.

Part VI

Administration (Sects. 64–76)

1. *Public Analysts.* Every Food and Drugs authority must appoint one or more public analysts who must not be engaged directly or indirectly in any trade or business connected with the sale of food or drugs in the authority's area and must possess the prescribed qualifications. (Under the Public Analysts Regs., 1939, a person shall not be qualified to be appointed as a public analyst under the Food and Drugs Act, 1938, unless either (*a*) he already holds an appointment as public analyst or (*b*) he holds the Diploma of Fellowship or Associateship of the Institute of Chemistry of Great Britain and Ireland and holds also a certificate granted by that Institute after an examination by them in the chemistry (including microscopy)

of food, drugs and water.) The appointment, the terms of the appointment and the removal of a public analyst must be approved by the Minister. The public analyst's remuneration may be paid either in addition to any fees he receives or on condition that all fees received by him are paid over to the authority. The provisions with respect to a public analyst apply also to a deputy. Every public analyst must report quarterly to his authority the number and results of the examinations made by him and the authority must send a copy of this report to the Minister.

2. A county council or a local authority may provide facilities for bacteriological and other examinations of food and drugs.

3. *Powers of sampling* (Sect. 68) (*a*). An authorised officer (known as a "sampling officer") of a Food and Drugs authority or of a local authority not being a Food and Drugs authority may procure samples of food and drugs for analysis, or for bacteriological or other examination. He may **purchase** samples of any food or drug; he may also **take** samples of (i.) any butter or cheese, or substances resembling them, exposed for sale and not properly marked as margarine, milk-blended butter or margarine-cheese, and (ii.) any food, or substance capable of being used in the preparation of food, found on premises which he has entered in the execution of his duties under this Act.

(*b*) A sampling officer may, at the request or with the consent of the purchaser, consignee or consumer, take at the place of delivery samples of any food delivered, or about to be delivered, to the purchaser, consignee or consumer in pursuance of a contract for the sale thereof to him. This subsection does not apply to milk.

(*c*) A sampling officer may examine or take samples of the contents of any container forwarded by a public conveyance which contains margarine, margarine-cheese or milk-blended butter if he has reason to believe the article is not consigned in accordance with the provisions of this Act.

(*d*) *Milk.* A sampling officer, or an inspector of the Ministry of Health, may take samples of milk at any dairy, or at any time while it is in transit, or at the place of delivery to the purchaser, consignee or consumer. An authorised officer of a county council may exercise these powers throughout the whole county whether the county council are the Food and Drugs authority or not.

Where milk sold or exposed for sale within the area of any council is obtained from a dairy outside that area, the medical officer of health or any other authorised officer of the council may by notice in writing require the medical officer of health or other authorised officer of the Food and Drugs authority within whose area the dairy is situated, or through whose area

the milk passes in transit, to procure, on his behalf, samples of the milk and to forward the samples to the officer who gave the notice or to such person as that officer may direct.

An authorised officer may procure samples of milk at a place outside his own district if the Food and Drugs authority of the area in which that place is situated have given their consent. Such consent may not be unreasonably withheld.

The working of the traffic in any railway premises must not be obstructed by reason of the taking of samples of milk in course of transit.

4. *Analysis of samples.* If a sampling officer considers that a sample of any food or drug he has procured should be analysed he must submit it to the public analyst for the area. A person, other than a sampling officer, may submit to the public analyst a sample of any food or drug he has purchased in the area. The public analyst must make his analysis as soon as practicable and certify the results in a prescribed form. He may demand in advance such fee, not exceeding one guinea, as may be fixed by the authority, in the case of a sample submitted by a person not being an officer of the Food and Drugs authority.

5. *Division of samples.* A person who has purchased a sample of any food or drug or has taken a sample of food must forthwith inform the seller or his agent of his intention to have the sample analysed by the public analyst. He must then divide the sample into three parts, each to be marked and sealed or fastened up, and must (*a*), if required so to do, deliver one part to the seller or other person responsible, (*b*) retain one part for future comparison, and (*c*), if he thinks fit, submit one part to the public analyst.

When a sample is taken of any food in transit or at the place of delivery, one part must be sent by registered post or otherwise to the consignor if his name and address appear on the container. A similar procedure is followed in the case of samples purchased from an automatic machine save that the sample is sent either to the proprietor of the machine or to the occupier of the premises.

6. *Special provisions as to the sampling of milk* (Sect. 71 and Third Schedule). A purveyor of milk, from whom a sample of milk has been procured, may be required to state the name and address of the seller or consignor from whom he received the milk. Within sixty hours the purveyor may serve on the authority by whose officer the sample was procured a notice requesting the authority to procure, as soon as practicable, a sample of milk from a corresponding milking in the course of transit or delivery to himself. If the purveyor has not served such a notice, he may not as defendant in any proceedings taken against him in respect of the sample plead a warranty

(see p. 597) as a defence. (The purveyor cannot make such a request if the milk from which the sample was procured was a mixture of milk obtained by him from more than one person.) If the authority do not procure such a sample no proceedings under this Act in respect of the original sample may be taken against the purveyor. Proceedings may be taken against the seller or consignor instead of, or as well as against, the purveyor.

If a sample of milk of cows in any dairy is procured in course of transit or delivery from that dairy the dairyman may within sixty hours serve on the authority a notice requesting them to procure as soon as practicable a sample of milk from a corresponding milking of the cows ("appeal to the cow"). Here again if the authority omit to comply with this request no proceedings under the Act in respect of this sample may be taken against the dairyman. Steps may, however, be taken at the dairy to ascertain whether or not the sample is a fair sample of the milk of the cows when properly and fully milked.

It is a defence in proceedings in respect of a sample of milk taken after the milk has left the defendant's possession for the defendant to prove that the churn or other vessel in which the milk was contained was effectively closed and sealed at the time when it left his possession but had been opened before the person by whom the sample was taken had access to it.

7. The Ministers of Health and of Agriculture may direct their officers to procure samples of food and have them analysed. Any fee for analysis is payable by the local Food and Drugs authority.

See Min. of H. Memo. 36/Foods (Revised 1939), "Procedure under the Food and Drugs Act, etc."

8. *Power of entry* (Sect. 77). Any authorised officer of a council, on producing if required some duly authenticated document showing his authority, has a right to enter any premises for the purposes of this Act at all reasonable hours. Twenty-four hours' notice must be given in the case of premises used only as a private dwelling house. The officer may, on sworn information, obtain a justice's warrant authorising entry if admission to any premises has been refused, if the premises are unoccupied, if the matter is one of urgency, or if any application for admission would defeat the object of the entry. Such a warrant remains in force for one month.

Any person who is admitted to a factory or workplace under these powers of entry and who discloses any information obtained by him regarding any manufacturing process or trade secret is liable to severe penalties unless such disclosure was made in the performance of his duty.

9. *Penalty for obstruction* (Sect. 78). Penalties are provided for wilful obstruction and for refusal to sell to a sampling officer, who tenders the proper price, or to permit such officer

to take, the quantity of any food or drug required as a sample. No person may be required to sell any food or drug exposed for sale in a duly labelled and unopened container except in the unopened container. It is also an offence to refuse to give assistance or information reasonably requested by an officer in the execution of his duties under the Act, or knowingly to make misstatements.

10. *Legal proceedings* (Sects. 79–83). Save when special penalties are provided, persons guilty of a first offence under this Act are liable to a fine not exceeding twenty pounds and in the case of a subsequent offence, to a fine not exceeding one hundred pounds or to imprisonment not exceeding three months, or to both such fine and such imprisonment.

Proceedings are taken before a court of summary jurisdiction and must ordinarily be commenced within twenty-eight days of the time when the sample was procured. The justice before whom the information is laid may extend the period in special circumstances to forty-two days.

In any proceedings in respect of an article sampled the summons must not be made returnable less than fourteen days from the day on which it is served, and a copy of any certificate of analysis must be served with it. That part of the sample retained by the person who procured it must be produced in court and the court may direct it to be sent to the Government chemist for analysis.

The certificate of a public analyst in the prescribed form is taken as evidence. If a sample of milk has been taken by an officer of one authority at the request of an officer of another authority, a certificate signed by the officer who took the sample stating that the provisions of the Act with regard to the taking of samples have been complied with is taken as evidence provided a copy of the certificate has been served on the defendant with the summons.

If a person against whom proceedings are brought can prove that the contravention was due to the act or default of some other person, that other person may be brought before the court and convicted and the original defendant acquitted.

Warranty (Sect. 84). In proceedings in respect of the sale of an article not of the nature, substance or quality demanded it is a defence for the defendant to prove that he purchased the article under a written warranty, that he had no reason to believe that the warranty was untrue and that the article was in the same state as when he purchased it. The defendant must send to the prosecutor, within seven days of the service of the summons, a copy of the warranty with a notice stating that he intends to rely on it in his defence and specifying the name and address of the person from whom he received it. He must send a similar notice to the warrantor. The defendant

must also prove that he has taken reasonable steps to verify the accuracy of a warranty given by a person resident outside the United Kingdom. A warrantor is entitled to appear at the hearing and to give evidence, and proceedings may be taken against a person giving a false warranty.

Default (Sect. 93). The Minister of Health, in the general interests of consumers, or the Minister of Agriculture and Fisheries, in the general interests of agriculture, may by order empower an officer of his department to act in place of a Food and Drugs authority who have failed to execute or enforce any of the provisions of this Act. Any expenses incurred must be paid by the authority.

Regulations with regard to food

The following regulations, which were made under various statutes, must now be regarded as regulations under the Food and Drugs Act, 1938.

1. **The Public Health (Shellfish) Regulations, 1934**

(1) If a M.O.H. considers that any person is suffering, or has recently suffered, from infectious or other disease attributable to shellfish, or that the consumption of shellfish exposed for sale within the district is likely to cause danger to health, he must endeavour to ascertain the layings from which such shellfish were derived, and must report thereon to his L.A.

(2) The L.A. may require any fishmonger supplying shellfish in the district to furnish to the M.O.H., within a certain time, a list of all the layings from which his supply of shellfish has been derived during the preceding six weeks.

(3) If the layings are not within the district of the L.A. concerned, the L.A. must make a representation to the L.A. of the district in which the laying is situate.

(4) The L.A., upon consideration of the report of the M.O.H. and after giving all persons interested a reasonable opportunity of making representations, may then make an order prohibiting the distribution for sale for human consumption of shellfish taken from the laying if they are satisfied that the consumption of such shellfish is likely to cause danger to the public health. They may further attach to an order such exceptions and conditions as they may think proper. (This enables a L.A. to prescribe as a condition of the sale of shellfish either re-laying in pure water, or sterilisation by steam, or cleansing in an establishment approved by the Minister of Health.)

(5) Any person aggrieved by an order may appeal to the Minister of Health, and the L.A. must inform the Minister of Health and the Minister of Agriculture and Fisheries of any action taken under these regulations.

2. **The Public Health (Condensed Milk) Regulations, 1923 and 1927.** See p. 609.

3. **The Public Health (Dried Milk) Regulations, 1923 and 1927.** See p. 610.

4. **The Public Health (Meat) Regulations, 1924 and 1935.** "Meat" means the flesh of cattle, swine, sheep or goats, including bacon and ham and edible offal and fat. In Circular 604, issued by the Ministry of Health on June 12, 1925, the Minister indicated that the definition of "meat" would not include rabbits, poultry, fish, butter, margarine, cheese, cooked meat, lard, sausages and other preparations of or containing meat.

"Stall" includes any stall, barrow or vehicle from which meat is offered for sale in a street or other open space or in any market-place.

Slaughter-houses and slaughtering. (1) A person shall not slaughter an animal for sale for human consumption unless he has, not less than three hours before the time of slaughtering, given to the L.A. notice of the day and time and of the place of slaughter. Except—

(*a*) In the case of regular slaughtering at fixed times on fixed days in any slaughter-house when written notice of this practice has been given; and

(*b*) In the case of emergency slaughter on account of injury, illness or exposure to infection of the animal, when notice must be given as soon as possible afterwards.

(2) The owner of an animal must forthwith give notice to the L.A. if after slaughter any portion of the organs or carcase appears to be diseased.

(3) No one may remove a carcase or the organs (other than the stomach, intestines and bladder) till after inspection or till removal has been authorised by the L.A. Except—

(*a*) Sheep, and animals slaughtered under exception (1) (*a*), above, unless disease appears to be present;

(*b*) in any event at the expiration of three hours from the time of slaughter or six hours from the delivery of notice relating thereto, whichever time may be later. If such time falls between 7 p.m. and 7 a.m. removal may not take place before 7 a.m.;

(*c*) in the case of emergency slaughter, when the carcase and organs may be removed to some convenient place.

(4) No gut-scraping, tripe-cleaning, manufacture or preparation of articles of food for man or for animals, household washing or work of any nature, other than is involved in the slaughter and the dressing of carcases, shall be carried on in any slaughter-house. No articles may be stored in any slaughter-house save such as are necessary for the slaughtering and dressing processes.

(5) No person shall blow or inflate with his breath, or in any other manner likely to cause infection or contamination, the carcase of any animal slaughtered for human consumption.

(6) No animal not intended for human consumption may be slaughtered in a slaughter-house.

"Slaughter-house" means such part of a slaughter-house as is used for the slaughtering of animals or the dressing or hanging of carcases for human consumption.

Meat marking. The Min. of H. may allow a L.A. to place on carcases a distinctive mark so devised as to indicate the identity of the L.A. and of the inspector using the mark. Such a mark shall not be affixed to any part of a carcase unless the whole carcase has been inspected and such part has appeared to be fit for the food of man.

A charge may be made not exceeding one shilling for each carcase or part of a carcase marked.

Stalls. A person selling or exposing for sale meat on any stall—

(1) Shall have his name and address legibly marked on some conspicuous part of the stall;

(2) shall cause the stall (if not in an enclosed and covered market-place) to be covered over and screened at the back and sides, so as to prevent mud, filth, and other contamination from being splashed or blown from the ground upon any meat on the stall;

(3) shall cleanse all implements after use and keep them in a cleanly condition;

(4) shall take all reasonable steps to prevent contamination of the meat by flies;

(5) shall not place any meat within 18 inches of the ground, save in a closed cupboard not less than 9 inches from the ground;

(6) shall keep all trimmings and refuse in properly covered receptacles apart from any meat intended for sale.

Shops, stores, etc. (1) No sanitary convenience shall communicate directly with any room where meat is deposited; no soil-drain opening shall be within such room; no such room may be used as a sleeping-place, nor may a sleeping-place communicate directly with such room; and, save in the case of a cold store, such room must be adequately ventilated.

(2) No solid or liquid filth may be deposited or allowed to accumulate in such room, and all walls and ceilings must be cleansed or whitewashed as often as may be necessary.

(3) All reasonable steps must be taken to guard against the contamination of meat by flies, and meat must be so placed as to prevent mud, filth, or other contamination being splashed or blown upon it. In Circular 604, mentioned on p. 599, it is stated that this provision should not be construed as requiring all butchers' shops to be provided with glass fronts.

(4) No gut-scraping, tripe-cleaning, or household washing may be carried on in a room where meat is deposited.

(5) All counters and implements must be thoroughly cleansed after use and kept at all times in a cleanly condition.

(6) All trimmings and refuse must be placed in properly covered receptacles and kept apart from any meat intended for sale.

Transport and handling. Vehicles used for conveying meat must be kept clean, and the meat must be adequately protected by a clean cloth or other suitable material if the vehicle is open at the top, back or sides, or if any other commodity is being conveyed therein.

Meat must not be allowed to come in contact with the ground, and all steps must be taken to prevent exposure of the meat to contamination.

Employers must see that all persons employed to carry meat in wholesale markets or stores wear clean washable head coverings and overalls.

5. **Public Health (Imported Food) Regulations, 1937.**

"Prohibited meat" means—

(*a*) Scrap meat which cannot be identified with a definite part of a carcase;

(*b*) meat comprising the wall of the thorax or abdomen from which has been detached any part of the pleura or (except in the case of meat derived from a pig) the peritoneum, other than a part necessarily removed in preparing the meat;

(*c*) meat from which a lymphatic gland, except a gland necessarily removed in preparing the meat, has been taken out;

(*d*) the head of an animal without the submaxillary gland.

"Meat products" means—

(*a*) Meat packed in airtight containers;

(*b*) cooked or dried meat;

(*c*) intestines and other parts prepared in the form of sausage casings;

(*d*) rendered animal fats except in margarine;

(*e*) pies, sausages and other prepared or manufactured articles of food containing any meat or cooked or dried meat other than fat.

"Official certificate" means a label or stamp which is affixed by a competent authority to any oversea meat or meat product and which is for the time being recognised by the Minister as showing—

(*a*) That the meat was derived from animals inspected ante- and post-mortem and passed in accordance with criteria satisfactory to the Minister; and

(*b*) that all necessary precautions for the prevention of danger to public health were taken in preparing and packing the meat or meat product.

Official recognition is given to a certificate by publication in the *London Gazette*.

The regulations apply to any vehicle bringing food to this country (ships and aircraft).

(1) The M.O.H. may examine any article of food before or after it has been landed. All facilities must be given him, and if necessary he may get a justice's warrant to search and examine. He may take samples and may by notice detain the food (not longer than forty-eight hours without consent of the importer) until the results of the examination are completed. If the food is diseased or unsound, the M.O.H. may seize it and apply to a justice to deal with it.

(2) No person shall import into England or Wales for sale for human consumption any prohibited meat or any meat or meat product not accompanied by an official certificate. Customs and Excise officers may detain doubtful cargoes till examined by the M.O.H. If the consignment comprises meat of either of these two classes the M.O.H. shall by notice in writing forbid the removal of the meat except for exportation. The L.A. must then give the importer notice that, unless he gives a written undertaking to export the meat at his own expense or to prove before a justice that the meat is not intended for sale for human consumption, the meat will be destroyed or disposed of under the supervision of the M.O.H.

Under the **Merchandise Marks (Imported Goods) No. 7 Order, 1934,** it is not permitted to import into or to sell or expose for sale in the United Kingdom any chilled beef, frozen mutton, frozen lamb, frozen pork, frozen beef, frozen veal, boneless beef, boneless veal, salted beef, salted pork and edible offals unless such meat bears a stamp or label indicating its origin. In a shop dealing solely in imported meat it is allowable to display a notice bearing the words, "All meat in this shop is imported meat of Empire (or foreign) origin."

6. **The Public Health (Preservatives, etc., in Food) Regulations, 1925–1940.**

The following are the schedules to the Regulations:—

The First Schedule.

PART I. ARTICLES OF FOOD WHICH MAY CONTAIN PRESERVATIVE AND NATURE AND PROPORTION OF PRESERVATIVE IN EACH CASE.

The articles of food specified in the first column of the following table may contain the preservative specified in the second column in proportions not exceeding the number of parts (estimated by weight) per million specified in the third column:—

Food.	Preservative.	Parts per million.
1. Sausages and sausage meat containing raw meat, cereals and condiments.	Sulphur Dioxide. .	450

Food.	Preservative.	Parts per million.
2. Fruit and fruit pulp, not dried:		
(a) Cherries	Sulphur Dioxide	3,000
(b) Strawberries and raspberries.	Do.	2,000
(c) Other fruit	Do.	1,500
3. Dried fruit:		
(a) Apricots, peaches, nectarines, apples and pears.	Do.	2,000
(b) Raisins and sultanas	Do.	750
4. Unfermented grape juice and non-alcoholic wine made from such grape juice if labelled in accordance with the rules contained in the second schedule to these regulations.	Benzoic Acid	2,000
5. Other non-alcoholic wines, cordials and fruit juices, sweetened or unsweetened.	Either Sulphur Dioxide or Benzoic Acid	350 600
6. Jam (including marmalade and fruit jelly prepared in the way in which jam is prepared).	Sulphur Dioxide	40
7. Crystallised and glacé fruit including candied peel.	Do.	100
8. Sugar (including solid glucose) and cane syrups.	Do.	70
9. Corn, syrup (liquid glucose)	Do.	450
10. Cornflour (maize starch) and other prepared starches.	Do.	100
11. Gelatine	Do.	1,000
12. Beer	Do.	70
13. Cider	Do.	200
14. Alcoholic wines	Do.	450
15. Sweetened mineral waters	Either Sulphur Dioxide or Benzoic Acid	70 120
16. Brewed ginger beer	Benzoic Acid	120
17. Coffee extract	Do.	450
18. Pickles and sauces made from fruit or vegetables.	Do.	250

Part II. Colouring Matters which may not be added to Articles of Food.

1. *Metallic Colouring Matters.*

Compounds of any of the following metals:—

Antimony,
Arsenic,
Cadmium,
Chromium,
Copper,
Mercury,
Lead,
Zinc.

2. *Vegetable Colouring Matter.*

Gamboge.

3. *Coal Tar Colours.*

Number in Colour Index of Society of Dyers and Colourists, 1924.	Name.	Synonyms.
7	Picric Acid	Carbazotic Acid.
8	Victoria Yellow	Saffron Substitute; Dinitrocresol.
9	Manchester Yellow	Naphthol Yellow; Martius Yellow.
12	Aurantia	Imperial Yellow.
724	Aurine	Rosolic Acid; Yellow Coralline.

The Second Schedule.

LABELLING OF ARTICLES OF FOOD CONTAINING PRESERVATIVE AND OF PRESERVATIVES.

1. The articles of food containing preservative to which the Rules as to labelling set out in this Schedule apply are sausages, sausage-meat, coffee extract, pickles and sauces, and (where the proportion of benzoic acid exceeds 600 parts per million) grape juice and wine. In retail shops it will be sufficient if a notice to the effect that the article contains preservative is exhibited in a conspicuous place so as to be easily readable by a purchaser. The Rules do not apply in the case of hotels, restaurants, or such other places where the article is sold for consumption on the premises.

2.—(1) Where any of the said articles of food contains preservative it shall bear a label on which is printed the following declaration or such other declaration substantially to the like effect as may be allowed by the Minister :—

(*a*) CONTAIN(S) PRESERVATIVE.

(2) The declaration shall be completed by inserting at (*a*) the word " This " or " These," followed by the name of the food as used in paragraph 1 of this Schedule.

(3) In the case of grape juice or wine to which these Rules apply there shall be added to the declaration the words " and is not intended for use as a beverage."

3.—(1) An article sold as a preservative shall bear a label on which is printed the following declaration or such other declaration substantially to the like effect as may be allowed by the Minister :—

THIS PRESERVATIVE CONTAINS (*a*) PER CENT. OF SULPHUR DIOXIDE.

(2) Where the article contains benzoic acid the words "Benzoic Acid" shall be substituted for the words "Sulphur Dioxide."

(3) The declaration shall be completed by inserting at (*a*) in words and figures, excluding fractions (*e.g.* "seventy (70)"), the true percentage of the sulphur dioxide or benzoic acid present in the article.

4. The prescribed declaration shall in each case be printed in dark block type upon a light coloured ground within a surrounding line, and no other matter shall be printed within such surrounding line. The type used shall be not less than one-eighth of an inch in height, or, in the case of grape juice or wine to which these Rules apply, one-sixteenth of an inch in height.

5. The label shall be securely affixed to the article or be part of or securely affixed to the wrapper or container, and in any case shall be so placed as to be clearly visible. If the article bears a label containing the name, trade mark, or design representing the brand of the article or the name and address of the manufacturer or dealer the prescribed declaration shall be printed as part of such label.

6. No comment on or explanation of the prescribed declaration (other than any direction as to use in the case of a preservative) shall be placed on the label or on the wrapper or container.

7. **The Public Health (Prevention of Tuberculosis) Regulations, 1925.** See p. 611.

8. **The Public Health (Imported Milk) Regulations, 1926.** See p. 608.

REGULATIONS WITH REGARD TO MILK

(See also p. 361.)

The Milk and Dairies Regulations, 1926 to 1943

The Regulations are enforced by borough councils and by the councils of urban and of rural districts.

REGISTRATION AND NOTICES

Every local authority must keep registers of all dairies and dairymen in their district, and no person may carry on the trade of dairyman unless he and his premises are registered (see note on p. 608). The L.A. must receive one month's notice in writing of an occupier's intention to use for the first time any building as a cowshed or dairy. The L.A. must notify the county council of all particulars of registration and of alterations made in the register.

GENERAL PROVISIONS FOR SECURING THE CLEANLINESS OF DAIRIES, ETC., AND FOR PROTECTING MILK AGAINST INFECTION AND CONTAMINATION

Every cowshed and building used for keeping milk (other than a cold store) must be provided with sufficient windows or other openings communicating with the external air so as to ensure proper lighting and ventilation.

Where milking is carried on after dark, adequate artificial lighting must be maintained.

There must be a satisfactory water supply protected from contamination, and receptacles used for storage and conveyance of water must be emptied and cleaned when necessary. The supply used for watering cows must be reasonably protected against drainage of foul water.

Milk must not be placed where it is liable to become contaminated or infected, and must not be kept in a kitchen, scullery, living-room or sleeping-room, or in any part of a building communicating

directly with a water-closet, earth-closet, privy, cesspool, or receptacle for ashes, or in a room used for sleeping or occupied by a case of infectious disease, or in a room which having been so occupied has not been disinfected, or in any room in which there is an untrapped drain inlet.

Vessels containing milk must be protected from flies and other contamination.

No noxious matter or soiled bed or body clothing may be conveyed through any part of a building used for the storage of milk.

All those engaged in milking or handling milk or milk receptacles must keep clothing, persons and receptacles in a cleanly condition.

No process in connection with the production of milk in any of its stages shall be carried on where there is liability to contamination from cowsheds, manure heaps, etc., and all appliances shall be similarly protected.

If a case of infectious disease occurs in the household of a person engaged in handling milk he shall at once notify the occupier of the registered premises, who shall immediately inform the medical officer of health of the district.

Should the medical officer of health of any district become aware that any such person is suffering from or has been in contact with infectious disease, he shall notify the occupier of the premises, and also the medical officer of health of the registering authority. When a medical officer of health is in possession of evidence that any person is suffering from infectious disease conveyed by milk supplied within the district, he may by notice specifying the evidence stop the sale of milk and milk products ; any such notice is operative for a period not exceeding twenty-four hours, but may be renewed for a similar period or periods ; if the infected milk has come from outside his own district then he must notify the medical officer of health concerned.

Any person who suffers damage or loss by reason of such a notice, when it is afterwards proved that no infectious disease was caused by the consumption of such milk, shall be entitled to full compensation.

If a medical officer of health suspects that any person employed on registered premises is suffering from or has recently been in contact with infectious disease, he may, after notice to the occupier, make an examination of all or any of the employees, and if necessary prohibit them from milking cows or handling milk in any way.

No person shall keep swine or poultry in any place where milk or milking utensils are kept, or in any place communicating directly therewith.

All vessels (including lids) and appliances used for any purpose which brings them into contact with milk must be thoroughly washed as soon as may be after use and must be cleansed and scalded with boiling water or steam before being used again. A solution of sodium hypochlorite approved by the Minister of Agriculture and Fisheries may be used in the cleansing of such utensils and all traces of such a substance must be removed from the utensils before they are brought into contact with milk. Utensils must be stored in a clean place, protected from dust and dirt, and may not be used for any other article than milk or milk products. Mechanical milkers need not be cleansed with boiling water or steam before being treated with a solution of sodium hypochlorite.

Special provisions applicable to cowkeepers

Cowsheds must be kept clean, and the interiors properly limewashed or sprayed with lime at least twice every year (April or May and September or October) and at other times when necessary.

Dung must be removed at least once daily and must not be so placed as to render uncleanly the access to any cowshed or milk room.

Milking must be carried out in good light (natural or artificial) and, before milking, the flanks, udders and teats of each cow must be cleaned; the hands of the milker must be washed and dried and, as far as practicable, kept dry; milking stools must be kept clean.

Nothing shall be done to cause dust within half an hour of milking, and immediately after milking the milk shall be removed from the cowshed and placed in a covered receptacle.

As soon as practicable the milk must be cooled to a temperature of not more than 5° F. higher than the temperature of the water available, but this does not apply in the following cases: Where milk is delivered by road to a collecting station to be cooled, or where it is used for the manufacture of butter, cream, cheese or other milk products on the premises, or where it is delivered at least twice a day on the day of production, or where it is delivered to the consumer immediately after milking.

On arrival at a collecting station milk that has not been previously cooled shall be cooled to a temperature not exceeding 55° F., unless used for the manufacture of milk products.

All cowsheds must be so constructed as regards floors and drainage as to prevent as far as possible the soiling of the cows, and to ensure the conveyance of liquid matters to a suitable drain outside the building.

Special provisions applicable to buildings used for sale, etc., of milk

The occupier shall cleanse as often as necessary all furniture and fittings so as to maintain a reasonable cleanliness, and the floors shall be cleaned with water at least once a day. Except in the case of buildings used for the sale of milk by retail, the floors shall be made of impervious material sloping to a channel leading to a drain outside the building so as to remove all liquid matter.

Conveyance and distribution of milk, churns, etc.

All receptacles used in the measurement, storage, or delivery of milk shall be such that the interior may be readily cleansed.

Every churn or receptacle other than bottles shall be thoroughly cleansed when empty and securely closed before being returned.

Every churn or receptacle, other than bottles, used for the conveyance of milk by road or rail must comply with the following requirements:—

The name and address of the owner must be permanently marked on or securely fixed to the churn or receptacle, which must be provided with a lid without openings and so constructed as to prevent access of dirt, dust and rain, or milk which may have been splashed above the lid.

All churns and receptacles containing skimmed or separated milk must be plainly marked accordingly in large type.

Churns or other receptacles must not be opened in railway vans or stations except for the purpose of checking and sampling milk.

When milk is delivered in bottles, every bottle shall be filled and closed on registered premises and not tampered with before delivery to the consumer.

Every person engaged in the conveyance or distribution of milk shall take all practicable precautions to prevent the milk being contaminated or exposed to heat.

The interior of every vehicle used for the conveyance of milk shall be kept clean, and no live animal or any article likely to contaminate the milk shall be conveyed at the same time. If any vehicle has been used for the conveyance of offensive matter it must be thoroughly cleansed before being used to carry milk.

DEFINITIONS

"Infectious disease" means dysentery and any notifiable disease to which the P.H.A., 1936, applies;

"Cowkeeper" means any person who keeps one or more cows for the purpose of the supply of milk;

"Milk" means milk intended for sale for human consumption or for use in the manufacture of products for sale for human consumption, and includes cream, skimmed milk and separated milk;

"Dairy" includes any farm, cowshed, milk store, milk shop or other place from which milk is supplied on or for sale, or in which milk is kept or used for purposes of sale or manufacture into butter, cheese, dried milk or condensed milk for sale, and, in the case of a purveyor of milk who does not occupy any premises for the sale of milk, includes the place where he keeps the vessels used by him for the sale of milk, but does not include a shop from which milk is not supplied otherwise than in properly closed and unopened receptacles in which it was delivered to the shop or a shop or other place in which milk is sold for consumption on the premises only.

"Registered premises" means any building or other premises required to be registered under the provisions of this order.

N.B. In the case of Burrows *v.* Rapson (King's Bench Division, April 29, 1927) it was decided that, where sterilised milk was sold in the bottles in which it was received on the premises and which had not been opened, the dairyman must be registered although his premises need not be.

Public Health (Imported Milk) Regulations, 1926.

"Local authority" means a port health authority and the council of a borough or urban or rural district which includes or abuts on any part of a customs port, which part is not within the jurisdiction of a port health authority.

"Milk" means milk (including skimmed milk and separated milk, but not including condensed or dried milk) intended for sale for human consumption or for use in the manufacture of products for human consumption.

1. Every L.A. shall enforce these regulations, and shall keep a register of persons to whom milk imported into their district may be consigned. Any officer of the L.A. may take a sample of such milk.

2. No person may receive imported milk unless he is registered.

3. Imported milk, on a sample being taken within the district of a L.A., must contain not more than 100,000 bacteria per cubic centimetre, and must be free from tubercle bacilli.

4. Power is given to the L.A. to remove from the register any person to whom milk is consigned if the milk does not comply with the provisions of these regulations. There is a right of appeal to a court of summary jurisdiction and to the next quarter sessions. If a person is removed from the register,

the L.A. must report the facts to the Min. of H., who may direct that such person be removed from the register of any other L.A.

Public Health (Condensed Milk) Regulations, 1923 and 1927.

Under the **Public Health (Condensed Milk) Regulations, 1923 and 1927** "milk" (*i.e.* prior to condensation) means milk containing not less than 12·4 per cent. of milk solids (including not less than 3·6 per cent. of milk fat) and "skimmed milk" means milk containing not less than 9 per cent. of milk solids other than milk fat. All condensed milks shall contain not less than the appropriate percentages of milk fat and milk solids as specified in the following table :—

Description.	Percentage of Milk Fat.	Percentage of Milk Solids, including Fat.
1. Full cream, unsweetened . .	9·0	31·0
2. Full cream, sweetened . .	9·0	31·0
3. Skimmed, unsweetened . .	—	20·0
4. Skimmed, sweetened . .	—	26·0

Every tin or other receptacle containing condensed milk shall bear a label upon which is printed such one of the following declarations as may be applicable or such other declaration substantially to the like effect as may be allowed by the Minister :—

(i.) In the case of full cream milk (unsweetened) :—

CONDENSED FULL CREAM MILK, UNSWEETENED.

THIS TIN CONTAINS THE EQUIVALENT OF
(*a*) PINTS OF MILK.

(ii.) In the case of full cream milk (sweetened) :—

CONDENSED FULL CREAM MILK, SWEETENED.

THIS TIN CONTAINS THE EQUIVALENT OF
(*a*) PINTS OF MILK, WITH SUGAR ADDED.

(iii.) In the case of skimmed milk (unsweetened) :—

CONDENSED MACHINE-SKIMMED MILK [or CONDENSED SKIMMED MILK], UNSWEETENED.

NOT TO BE USED FOR BABIES.

THIS TIN CONTAINS THE EQUIVALENT OF
(*a*) PINTS OF SKIMMED MILK.

(iv.) In the case of skimmed milk (sweetened) :—

CONDENSED MACHINE-SKIMMED MILK [or CONDENSED SKIMMED MILK], SWEETENED.

NOT TO BE USED FOR BABIES.

THIS TIN CONTAINS THE EQUIVALENT OF (*a*) PINTS OF SKIMMED MILK, WITH SUGAR ADDED.

The details regarding types of print, etc., are the same as those prescribed for dried milk.

Public Health (Dried Milk) Regulations, 1923 and 1927.

Under the **Public Health (Dried Milk) Regulations, 1923 and 1927**, all dried milk, other than that sold in receptacles whose gross weight exceeds ten pounds, must contain—

(*a*) In the case of dried full cream milk, not less than 26 per cent. of milk fat.

(*b*) In the case of dried three-quarter cream milk, not less than 20 per cent. of milk fat.

(*c*) In the case of dried half cream milk, not less than 14 per cent. of milk fat.

(*d*) In the case of dried quarter cream milk, not less than 8 per cent. of milk fat.

" Milk," " Three-quarter cream milk," " Half cream milk " and " Quarter cream milk " mean milk containing not less than the following percentages :—

	Milk fat.	Milk solids (including fat).
Milk	3·6	12·4
Three-quarter cream milk	2·7	11·6
Half cream milk	1·8	10·8
Quarter cream milk	0·9	9·9

and " skimmed milk " means milk containing not less than 9 per cent. non-fatty solids.

Every tin or other receptacle containing dried milk (other than dried milk to which sugar or some other substance has been added) shall bear a label upon which is printed such one of the following declarations as may be applicable or such other declaration substantially to the like effect as may be allowed by the Minister :—

(i.) In the case of full cream milk, that is to say, dried milk containing not less than 26 per cent. of milk fat :—

DRIED FULL CREAM MILK.

THIS TIN CONTAINS THE EQUIVALENT OF (*a*) PINTS OF MILK.

(ii.) In the case of partly skimmed milk, that is to say, dried milk containing not less than 8 per cent. but less than 26 per cent. of milk fat :—

DRIED PARTLY SKIMMED MILK.
((*b*) CREAM).

SHOULD NOT BE USED FOR BABIES EXCEPT UNDER MEDICAL ADVICE.

THIS TIN CONTAINS THE EQUIVALENT OF (*a*) PINTS OF (*b*) CREAM MILK.

(iii.) In the case of skimmed milk, that is to say, dried milk containing less than 8 per cent. of milk fat :—

DRIED MACHINE-SKIMMED MILK
[OR DRIED SKIMMED MILK].

NOT TO BE USED FOR BABIES.

THIS TIN CONTAINS THE EQUIVALENT OF (*a*) PINTS OF SKIMMED MILK.

(*a*) The prescribed declaration shall be printed in dark block type upon a light-coloured ground.

(*b*) There shall be a surrounding line enclosing the declaration and in the case in which the words "not to be used for babies" are required to be used there shall be another such line enclosing those words.

(*c*) The distance between any part of the words "not to be used for babies" and the surrounding line enclosing those words shall be not less than one-sixteenth of an inch.

(*d*) No matter other than that hereinbefore prescribed shall be printed within either surrounding line.

(*e*) The type used for the declaration shall not in any part be less than one-eighth of an inch in height (or if the gross weight of the tin or other receptacle does not exceed twelve ounces, one-sixteenth of an inch in height) and the type used for the words "not to be used for babies" shall not be less than twice the height of any other part of the declaration.

N.B. There shall be inserted at (*a*) the appropriate number in words and figures, *e.g.* "one and a half (1½)," and at (*b*) the word "Three-quarter" if the percentage of milk fat is not less than 20 ; "Half" if less than 20 but not less than 14 ; and "Quarter" if less than 14 but not less than 8.

Public Health (Prevention of Tuberculosis) Regulations, 1925.

1. No person who is aware that he is suffering from tuberculosis of the respiratory tract shall, in connection with a dairy, do any work involving the milking of cows, the treatment of milk, or the handling of milk vessels.

2. If a L.A., on a written report of their M.O.H., are satisfied that a person residing in their district is so suffering and is so engaged, and *is in an infectious state*, they may by notice in writing, signed by the clerk or by the M.O.H., require such person to discontinue his occupation on or before a specified date.

3. There is appeal to a court of summary jurisdiction, and compensation is obtainable by any person who sustains damage in relation to any matter as to which he is not himself in default.

The Milk (Special Designations) Regulations, 1936 to 1943.

The following definitions should be noted :—

"Dealer" means any person who sells milk either by wholesale or by retail and any person to whom milk is delivered for the purpose of being used in any manufacturing process.

"Tuberculin test" means a tuberculin test of an animal either made by an inspector or made by a private veterinary surgeon with such tuberculin and in such manner as the Minister may direct.

"Inspector" means a veterinary inspector appointed by the Minister of Agriculture and Fisheries.

"Private veterinary surgeon" means a veterinary surgeon approved by the licensing authority.

The Orders provide :—

1. The special designations which may be used in relation to milk are "**Tuberculin Tested,**" "**Accredited,**" and "**Pasteurised.**" Licences authorising the use by producers of the first two designations are granted by county and county borough councils; all other licences are granted by the councils of boroughs and urban and rural districts. Licences are required in respect of establishments where designated milk is (*a*) produced, (*b*) bottled, (*c*) pasteurised, or (*d*) sold retail. A supplementary licence is required in respect of milk sold from a shop outside the area of the licensing authority. A licence to pasteurise milk covers any shop in the licensing authority's area from which the milk is sold by the same dealer. The fees payable to the licensing authority (from 2*s.* to £2 2*s.* annually) in respect of each of these licences are prescribed but the authority may dispense with their payment if they think fit.

2. When a producer applies for a licence to use the designation "Tuberculin Tested" he must either satisfy the licensing authority that his herd is an "attested herd" (see p. 366) or that his herd has been clinically examined and tuberculin tested by an inspector, or must furnish certificates of a clinical examination and a tuberculin test made by a private veterinary surgeon. All such tests and examinations must be made not more than one month before the date of application for a licence. All reactors and diseased animals must have been segregated or removed from the herd.

When a producer applies for a licence to use the designation "Accredited" he must either satisfy the licensing authority that the milch cows in the herd have been examined clinically by an inspector, or must furnish the authority with a private veterinary surgeon's certificate of a clinical examination of the milch cows. These examinations must be made within one month before the date of application. All diseased animals must have been segregated or removed from the herd.

3. Under the Milk (Special Designations) Regulations, 1941, a pasteuriser's licence may be granted by a licensing authority either in respect of the "Holder" process or of "High Temperature Short

Time" pasteurisation. An applicant for a licence (otherwise than in renewal of an existing licence) must state whether he desires a licence in accordance with the conditions for the "Holder" process as laid down in the Orders for 1936 and 1938 or for a licence in accordance with the Regulations of 1941 which provide for the alternative method.

4. A licensing authority may refuse to grant or may suspend or revoke a licence. There is an appeal to the Minister whose decision is final.

General conditions subject to which licences may be granted (Second Schedule). 1. All arrangements regarding the production, storage, treatment and distribution of the milk must be such as to satisfy the licensing authority.

2. The designated milk must be kept separate at all stages from all other milk unless it is in sealed containers. Any vessel or apparatus at any time used for any other milk must be cleansed and sterilised before being used for designated milk. No room in a dairy may be used for designated milk and any other milk unless either the former or the latter is in sealed containers. The holder of a licence shall not for the purpose of the sale or advertisement of the milk to which the licence applies refer to it by any such designation (other than the one authorised by the licence) as is calculated to suggest that it is tested, approved or graded by any competent person.

3. Accurate records must be kept showing the quantities of such milk produced, purchased and sold, and the names and addresses of the persons from whom the milk was purchased and to whom it was sold, otherwise than by retail.

4. Authorised persons must be given full permission to inspect and take samples free of charge.

Tuberculin Tested (Third Schedule). *Producers only*. 1. Every animal must be tuberculin tested at an interval of not less than two and not more than six months after the last preceding test, and, in the case of an animal born and bred in the herd, before it attains the age of twelve months. An inspector may make a special tuberculin test of any animal of the herd at an interval of not less than two months after the last preceding test or, if the animal has not previously been tested, at any time. No animal may be added to the herd unless it has passed the test within fourteen days or unless it comes from an "attested" or similar herd and has proved to be a non-reactor. With the exception of animals taken from "attested" or similar herds, all animals added to the herd must be segregated for two months and at the end of that time again tested with tuberculin. Unless the licensing authority otherwise determine, the examinations and tuberculin tests must be made by an inspector.

2. No animal may be injected with tuberculin save at the time of the prescribed tests and none may be vaccinated with live *Brucella abortus* except with the approval of the Minister of Agriculture and Fisheries and with a vaccine approved by him.

3. All reactors must be removed from the herd.

4. All animals must be marked with an identification mark and a complete register of animals kept.

5. Every animal must be clinically examined at intervals of not more than six months by an inspector or by a private veterinary surgeon—the latter's certificate must be sent to the authority within seven days of the date of the examination.

6. If an animal is suffering from any disease likely to affect the milk injuriously it must be segregated or removed from the herd and the special designation must not be used in relation to its milk.

7. A record must be kept of all animals segregated or removed

from the herd, showing reasons for isolation and manner of disposal.

8. The herd must be completely isolated from all other cattle.

9. Unless the milk is bottled by the producer, it must be consigned from the dairy in unventilated sealed containers marked with the address of the dairy, the day of production (morning or evening) and the words "Tuberculin Tested Milk."

Dealers (whether producers or not) by whom the milk is delivered to consumers. 1. Unless the milk is delivered to the consumer in the containers in which it is received, the seals being unbroken, it must be delivered either in bottles or in other suitable containers of not less capacity than two gallons. A "bottle" means an approved container of a capacity not exceeding one quart.

2. Every bottle must be tightly closed and securely fastened either with a cap overlapping the lip of the bottle or in some other suitable manner approved by the licensing authority. The cap must bear the address of the bottling establishment and the words "Tuberculin Tested Milk" and *may* also bear (*a*) the day of production (morning or evening), (*b*) the name of the bottler, (*c*) the words "Produced from cows which have passed the tuberculin test" and (*d*), if the milk has been bottled at the place of production, the word "(Certified)."

If there is no cap on which the wording may suitably be placed, it must be placed within a surrounding line on the container itself.

3. If containers other than bottles are used, they must be closed with a tightly fitting cover and suitably sealed and labelled.

All dealers (whether producers or not). 1. The milk must not at any stage be treated by heat or in any other manner likely to affect its nature or qualities, save that, where a licence authorising the use of the designation "Pasteurised" in relation to such milk has been granted, the milk may be treated in accordance with the conditions of such licence. In such a case the word "(Pasteurised)" must be added after the words "Tuberculin Tested Milk" and must be printed in block letters which may not be smaller than the letters used for the words "Tuberculin Tested Milk."

2. Milk if not pasteurised must satisfy a methylene blue reduction test and must not contain any coliform bacillus in 1/100 of a millilitre (the tests to be carried out in such manner as the Minister may direct) in the case of :—

(*a*) any sample of milk in relation to which the special designation is used ; and

(*b*) any sample of milk from the herd in respect of which a licence authorising the use of the special designation is in force (whether the designation is used in relation to that milk or not), if the sample is taken before the milk has been placed in bottles or other containers for delivery to the consumer and either while it is in the possession of the producer or before the containers in which it is consigned to another dealer are opened by that dealer.

Before the test is begun any sample to which paragraph (*b*) applies must be kept at atmospheric temperature until 6 p.m. on the day of production if it is from a morning milking and until 10 a.m. on the next day if it is from an afternoon milking, and any other sample may be kept at atmospheric temperature for a period not exceeding two hours. If the test is not then immediately begun the milk must be cooled and kept at a temperature from 32° to 40° F. for a further period not exceeding eighteen hours and the test must be begun at the end of that period.

A sample taken at any date from the 1st May to the 31st October shall be regarded as satisfying the methylene blue reduction test if

it fails to decolourise the methylene blue in 4½ hours, or in 5½ hours if taken between the 1st November and the 30th April.

3. The milk if pasteurised must not contain at any time after pasteurisation and before delivery to the consumer more than 30,000 bacteria per millilitre. The test must be carried out in such manner as the Minister may direct.

Accredited. *Producers only.* 1. Every milch cow in the herd must be examined, either by an inspector or by a private veterinary surgeon, at such times and as often as may be required by the Minister of Agriculture and Fisheries not being less often than once a year. Any certificate of a private veterinary surgeon must be sent to the authority within seven days of the date of the examination.

2. Any animal showing evidence of disease likely to affect the milk injuriously must be segregated or removed from the herd and the special designation may not be used in relation to its milk. A record must be kept of such animals showing the reasons for segregation and the manner of disposal.

3. The herd may not contain any animal which to the knowledge of the producer had, *before its introduction into the herd*, been tested with tuberculin and had reacted to the test.

N.B. This means that the owner of an accredited herd may have a trial tuberculin test of his herd made without his being compelled to dispose of the reactors.

4. All milch cows in the herd must be marked with an identification mark and a complete register of such cows must be kept.

5. The cows in milk in the herd must be kept separate from all other cows in milk.

6. Unless the milk is bottled by the producer, it must be consigned from the dairy in an unventilated sealed container labelled or marked with the address of the dairy, the day of production (morning or evening) and the words "Accredited Milk."

Dealers (whether producers or not) by whom the milk is delivered to consumers. The conditions applicable here are similar to those laid down in the case of "Tuberculin Tested Milk" save that in the wording to be placed on the cap or on the container itself the words "Accredited Milk" are substituted for "Tuberculin Tested Milk," and the words "Farm bottled" for "(Certified)." The words "Produced from cows which have passed the tuberculin test" cannot, of course, be used.

All dealers (whether producers or not). Here too the conditions and the tests which the milk must satisfy are the same as those for "Tuberculin Tested Milk." The milk must not at any stage be treated by heat.

Pasteurised. 1. (*a*) "Holder" process. The milk must be retained at a temperature of not less than 145° F. and not more than 150° F. for at least thirty minutes and be immediately cooled to a temperature of not more than 55° F. (*b*) "High Temperature Short Time" process. The milk must be retained at a temperature of not less than 162° F. for at least fifteen seconds and be immediately cooled to a temperature of not more than 55° F.

2. The milk must not be so heated more than once and must not be otherwise treated by heat.

3. Such indicating and recording thermometers as the licensing authority may require must be inserted in suitable places in the apparatus used for pasteurising during the whole of the pasteurising process, and in the case of "High Temperature Short Time" pasteurisation the apparatus must be thermostatically controlled and be provided with a device which will automatically divert the flow of milk not retained at a temperature of not less than 162° F. for at least fifteen seconds. The type of apparatus and thermometers

used and the methods employed must be such as are satisfactory to the licensing authority.

4. Temperature records must be made and must be preserved for a period of at least one month.

5. After the milk has left the pasteurising apparatus it must not be placed in any apparatus or storage vessels which are at any time used for milk which has not been pasteurised.

6. Every vessel in which the milk is transported or is exposed or offered for sale must be labelled " Pasteurised Milk."

7. On a sample being taken after pasteurisation and before delivery to the consumer the milk must not contain more than 100,000 bacteria per millilitre. The test must be done in such manner as the Minister may direct.

[Memo. 139/Foods, Ministry of Health, January, 1937, gives detailed instructions regarding bacteriological tests for graded milk.]

The number of licences at 31st March, 1939, was 3,122 for producers of tuberculin tested milk and 22,996 for accredited ; for distributing pasteurising establishments it was 676.

Tuberculosis Order, 1938 (issued by the Min. of Ag. and Fish.).

This Order provides for the slaughter of certain types of tuberculous animals, with compensation to the owners. The local authority under this Order means the local authority under the Diseases of Animals Acts, *i.e.* county councils and councils of boroughs with a population of 10,000 or over at the census of 1881.

1. Every person having in his possession one of the following must forthwith notify the fact to a police constable or to a veterinary inspector of the Min. of Ag. and Fish. :—

(*a*) Any cow which is, or appears to be, affected with tuberculosis of the udder, indurated udder, or other chronic disease of the udder ;

(*b*) any bovine animal which is, or appears to be, affected with tuberculous emaciation ;

(*c*) any bovine animal which is affected with a chronic cough and showing definite clinical signs of tuberculosis.

A veterinary surgeon finding any such animal in his private practice must forthwith make a similar notification. The police constable must inform the local veterinary inspector of the Min. of Ag. and Fish. and an inspector of the L.A.

2. An inspector of the L.A. on receiving such information must as soon as possible visit the place where the animal is kept and, by notice, require the detention and isolation of the affected animal, the separation from all other milk and the sterilisation of the milk of an affected cow, and the treatment by steam or boiling water of any utensil in which such milk has been placed.

3. Where a veterinary inspector of the Min. of Ag. and Fish. has reasonable grounds for supposing that there is an affected animal on any premises he must examine it and any other bovine animal he considers it desirable to examine. If he finds an animal affected with tuberculosis as above or *a cow giving*

tuberculous milk he must notify the owner and cause the animal to be slaughtered. The owner may appeal to the Min. of Ag. and Fish. If the value of an animal exceeds fifty pounds the animal may not be slaughtered without the consent of the Minister. The market value of the animal is determined before slaughter by agreement between the Minister and the owner or, if they fail to agree, by a valuer. The market value is the price that might reasonably have been obtained from a purchaser in the open market who had only such knowledge of the existence of disease in the animal as might reasonably have been obtained by inspection of the animal.

4. As soon as possible after the slaughter of the animal the carcase must be examined by a veterinary inspector of the Ministry who may submit specimens of any lesions to a pathological institution approved by the Minister. The owner or his representative is entitled to be present at the post-mortem examination. [Veterinary inspectors of the Ministry have been instructed to notify local health authorities of intention to slaughter and to see that no part of a carcase is removed for human consumption, except with the written permission of the M.O.H. or other competent officer of the local health authority.]

5. Compensation shall be paid by the Minister as follows :—

(*a*) If the animal was not suffering from tuberculosis—the market value of the animal and a further sum of twenty shillings ;

(*b*) if tuberculosis (other than advanced tuberculosis)—three-fourths of the market value, or thirty shillings, whichever sum is the greater, after deducting from such sum one-half of the reasonable costs of any valuer appointed ;

(*c*) if advanced tuberculosis—one-fourth of the market value, or a sum of thirty shillings, as in (*b*).

6. Advanced tuberculosis means for the purposes of this Order—

(*a*) Miliary tuberculosis of both lungs ;

(*b*) diffuse lesions of the pleura and peritoneum ;

(*c*) where the infection of the glands is sufficient to indicate widespread disease ;

(*d*) where, in addition to lesions in the respiratory and digestive tracts, there are also lesions in the substance or membranes of any two of the following : spleen, kidney, udder, any part of the reproductive system and any part of the central nervous system.

7. Suspected animals in markets, fairs and sales must be removed either to the premises from which they were brought or at the option of the owner to other suitable premises or to a slaughter-house. If the animal is removed to a slaughter-

house it must be slaughtered by the owner within ninety-six hours of its arrival—no compensation is payable in respect of such an animal.

8. The occupier of any premises on which there has been an affected animal must, if so required by the veterinary inspector of the Ministry, cleanse and disinfect at his own expense that part of the premises in which the animal has recently been kept.

The **Therapeutic Substances Act, 1925,** provides for the regulation of the manufacture, sale and importation of vaccines, sera and other therapeutic substances. The substances to which the Act applies are :—

1. Vaccines, sera, toxins, antitoxins and antigens.
2. Salvarsan and analogous substances used for the specific treatment of infective disease.
3. Insulin.
4. Preparations of the posterior lobe of the pituitary body intended for use by injection.

Power is given to add to these substances by regulations.

No person may manufacture or import any of these substances unless he has obtained a special licence from the Minister of Health, the Scottish Department of Health or the Minister of Home Affairs for Northern Ireland. Joint advisory committees are set up under the Act for framing regulations and for securing uniformity of standards.

Regulations were issued in 1930, 1931, 1935 and 1937 and dealt with :—

(*a*) Licensing of manufacturers ;

(*b*) provisions as to names of therapeutic substances and containers, labels, etc. ;

(*c*) standards of strength, quality and purity and appropriate tests ;

(*d*) licensing of importers ;

(*e*) research licences.

The schedules attached to these regulations lay down provisions applicable to : Bacterial vaccines, vaccine lymph, all sera from living animals, anti-bacterial and anti-toxic sera for which no potency test is prescribed, reagents used in the Schick test, diphtheria prophylactic, tuberculin, anti-dysentery sera, diphtheria anti-toxin, tetanus anti-toxin, gas gangrene anti-toxin, staphylococcus toxoid, staphylococcus anti-toxin, anti-pneumococcus serum, arsphenamine and its derivatives, neoarsphenamine, sulpharsphenamine, insulin, pituitary (posterior lobe) extract, and surgical ligature and surgical suture.

Severe penalties are provided for offences under the Act or Regulations.

Dangerous Drugs Acts, 1920–1932. These Acts and the regulations made under them are administered by the Home

Office, but medical officers of the Ministry of Health usually conduct any inspections required.

The drugs and preparations involved are the raw materials —raw opium, coca leaves and Indian hemp; and the dangerous drugs—medicinal opium, extracts and tinctures of Indian hemp, cocaine and ecgonine and their salts, diacetylmorphine (heroin) and its salts, dihydro-oxycodeinone and its salts, dihydrocodeinone and its salts, codeine and dionin and their salts, and any preparation containing $\frac{1}{5}$ per cent. or more of morphine, or $\frac{1}{10}$ per cent. or more of cocaine or ecgonine, or any proportion of diacetylmorphine, dihydro-oxycodeinone or dihydrocodeinone.

No person may bring into, or take out of, the country or carry on any process of manufacture of any of these drugs unless he is licensed by the Home Secretary, and no person is allowed to be in possession of the drugs unless he is licensed or otherwise authorised for the purpose. Registered medical practitioners and dentists are " authorised " persons, but only in " so far as is necessary for the practice of their profession." Prescriptions for medicines containing a dangerous drug (*a*) must be in writing and be dated, (*b*) must be signed with the usual signature of the doctor or dentist, (*c*) must bear the address of the doctor or dentist and the name and address of the patient, and (*d*) must specify the total amount of the drug to be supplied. A register of purchases of such drugs by the doctor or dentist and a register of drugs supplied by the doctor must be kept in prescribed form. All dangerous drugs must be stored under lock and key. Similar appropriate provisions apply also to dispensing pharmacists, who may not sell any of these drugs except on the prescription of a doctor, dentist or registered veterinary surgeon. (Home Office Memo. D.D.101/3, March, 1929.)

In the Poisons List Confirmation Order, 1935 (amended by the Poisons List (Amendment) Orders, 1937, 1938 and 1940), and the Poisons Rules, 1935–1942, made under the **Pharmacy and Poisons Act, 1933,** a schedule of poisons has been compiled and the conditions laid down that must be complied with in their manufacture, storage and sale. (See Home Office Memo. Poisons No. 3 (Practitioners and Hospitals) on the provisions of the Pharmacy and Poisons Act, 1933—issued 1936.)

The **Pharmacy and Medicines Act, 1941,** prohibits the advertisement of remedies for the relief or cure of Bright's disease, cataract, diabetes, epilepsy or fits, glaucoma, locomotor ataxy, paralysis or tuberculosis or substances to procure miscarriage. Exceptions are made for advertisements published by a local authority or voluntary hospitals or in journals of a technical character for circulation to doctors and other professional classes. The prohibition does

not apply to surgical appliances, deaf aids and similar articles. The Act also forbids the sale of medicines on or after July 1st, 1942, without the disclosure on the container, wrapper or label of their composition or active constituents either in specific terms or by reference to the British Pharmacopoeia or the British Pharmaceutical Codex, unless the medicine is prescribed for the needs of a particular person and supplied for his own use. The Act also makes minor amendments to the Pharmacy and Poisons Act.

HOUSING

Special legislation dealing with housing may be said to have had its origin in the Shaftesbury Acts of 1851, which gave permission to local authorities (as then constituted) to provide lodging-houses and common lodging-houses. In 1855 another Act authorised the incorporation of companies for the erection of dwelling-houses for the working classes. Societies began to be formed about this time to promote such building, and building societies too began to make available funds for enabling every man to become his own landlord. The Torrens Acts of 1868 and 1879 and the Cross Act of 1875 provided for the repair or closure and demolition of single unfit houses and for the reconstruction of insanitary areas. In 1884 a Royal Commission on the Housing of the Working Classes was set up, and in the following year the first Housing of the Working Classes Act was passed. In 1890 came another Housing Act which remained the principal Act till 1925. This Act of 1890 was divided into three parts—Part I. dealt with slum clearance, Part II. with repair or closure and demolition of single unfit houses, and Part III., which was adoptive, enabled local authorities to build and maintain houses for working-class persons. In 1899 the Small Dwellings Acquisition Act permitted local authorities to advance money to a person residing in a house to enable him to become its owner. The scope of this Act has been greatly widened since then. The only other important piece of legislation before the outbreak of the War (1914–18) was the Housing and Town Planning, etc., Act, 1909, which, in an adoptive part, enabled local authorities to draw up town planning schemes for their areas.

In 1919 the need for houses had become acute. Practically all building had come to a standstill during the War, and an extreme shortage of accommodation was the result. In that year another Housing, Town Planning, etc., Act was passed, which had for its objects slum clearance and the building of houses by local authorities. Its most novel feature was the limitation of the liability of local authorities to the product of a penny rate. In addition, it endeavoured to bring compulsion on local authorities to build. Unfortunately prices began to soar and

the cost of houses became so high that both Government and local authorities took fright. The Housing, etc., Act, 1923, offered a Government subsidy of £6 per house for twenty years or a lump sum, and promised a grant equal to 50 per cent. of a local authority's estimated average annual loss on slum clearance. The Housing (Financial Provisions) Act, 1924, provided an increased subsidy (£9 per house for forty years)—a subsidy which was reduced considerably by an Act passed in 1926. A consolidating Housing Act was passed in 1925 and in 1930 another Housing Act dealt with the clearance and improvement of unhealthy areas. The Housing Act, 1935, made further provision for the prevention and abatement of overcrowding, the re-development of urban areas and the reconditioning of buildings. Finally the Housing Act, 1936, consolidated the Housing Acts, 1925 to 1935, and certain other enactments relating to housing.

In November, 1918, the number of houses in England and Wales was just under eight million. Between that time and the 31st March, 1940, about four million new houses were provided in England and Wales, of which over a million were built by local authorities and about three million by private enterprise. Since the inception in 1933 of the five-year programme for the clearance of the slums more than a million people have been removed from slum houses into new houses. The total annual contribution from public funds in respect of housing was about £19,000,000 in 1938–39 of which sum approximately £3,800,000 came from local authorities.

The average cost of all non-parlour houses during 1938–39 was £361, excluding charges for land, roads and sewers. Such charges amount to between £45 and £90 per house in urban areas and £10 to £40 in rural.

Government subsidies are now available only in respect of housing accommodation required for the abatement of overcrowding, slum clearance and the rehousing of the persons displaced. Special assistance is given, however, towards the provision of houses for members of the agricultural population (see p. 634).

Rent restriction dates for practical purposes from the Rent Restriction Act, 1920, although control of rents was introduced as a temporary measure in 1915. The Act of 1920 controlled all houses built before 2nd April, 1919, and having a rateable value of not more than £105 (London) and £78 (Provinces), but as the housing position improved control was lifted until by 1939 no houses were controlled that had a rateable value of more than £35 (London) and £20 (Provinces). Control has again been necessitated and since the Rent and Mortgage Restriction Act of 1939, rents have been limited by statute for all unfurnished dwelling-houses with a rateable value in April,

1939, of £100 (London) and £75 (Provinces). Houses belonging to local authorities are excluded.

Housing Act, 1936

Definitions

(*a*) The L.A. for the purposes of this Act means the council of a borough, urban district, or rural district.

(*b*) "Sanitary defects" include lack of air space or of ventilation, darkness, dampness, absence of adequate and readily accessible water supply or sanitary accommodation or of other conveniences and inadequate paving or drainage of courts, yards or passages. (Sect. 188.)

(*c*) For the purposes of re-housing, the expression "working class" includes mechanics, artisans, labourers, and others working for wages, hawkers, costermongers, persons not working for wages but working at some trade or handicraft without employing others, except members of their own family, and persons other than domestic servants whose income in any case does not exceed an average of three pounds a week, and the families of any of such persons who may be residing with them. (Eleventh Schedule.)

(*d*) "Agricultural population" means persons whose employment or latest employment is or was in agriculture or in an industry mainly dependent upon agriculture, and includes also the dependants of such persons; the expression "agriculture" includes dairy-farming and poultry farming and the use of land as grazing, meadow, or pasture land, or orchard or osier land, or woodland, or for market gardens or nursery ground. (Sect. 115.)

Sanitary condition of houses

Obligation of lessors of small houses. In any contract for letting for habitation a dwelling-house at a rent not exceeding £40 in London and £26 elsewhere there shall be implied a condition that the house is at the commencement of the tenancy, and an undertaking that the house will be kept by the landlord during the tenancy, in all respects reasonably fit for human habitation, except :—

(1) A house let for a term of not less than three years upon the terms that it is put by the lessee into a fit condition and the lease is not determinable at the option of either party before the expiration of the lease.

(2) A house, situated elsewhere than in London or in an urban area with a population at the last census of 50,000 or upwards, the rent of which exceeds £16, provided the contract for letting was made before 31 July, 1923.

In the case of any dwelling-house which is occupied, or of a type suitable for occupation, by the working classes, the name and address of the M.O.H. and of the landlord or other person directly responsible for keeping the house fit must be inscribed in the rent-book or delivered in writing to the tenant before any rent is collected.

Inspection of the district. It is the duty of every L.A. to have their district inspected from time to time to ascertain whether any dwelling-house is unfit for human habitation, and for that purpose to comply with such regulations as the Minister may prescribe.

Under the Housing (Consolidated) Regulations, 1925 and 1932, the methods of inspection and of keeping records are laid down, and in addition the M.O.H. is directed to include in his annual report information and particulars in tabular form regarding the number of houses inspected under the Housing Acts and the action taken as a result of such inspections (see also "Abatement of overcrowding," p. 630).

The inspection should be made by the M.O.H. or by an officer acting under his supervision, and should be directed toward the following matters :—

(1) The adequacy and accessibility of the water supply.
(2) The arrangements for preventing the contamination of the water supply.
(3) The adequacy and accessibility of sanitary accommodation or of other conveniences.
(4) Drainage.
(5) The condition of the house in regard to light, the free circulation of air, dampness and cleanliness.
(6) The paving, drainage and sanitary condition of any court-yard or passage or outhouses belonging to or occupied with the house.
(7) The arrangements for the deposit of refuse and ashes.
(8) The existence of any underground room unfit for human habitation.
(9) Any defects in other matters which may tend to render the house in any respect unfit for human habitation.
(10) The extent to which by reason of disrepair or sanitary defects the house falls short of the provisions of any bylaws in operation in the district or of the general standard of housing accommodation for the working classes in the district.

Bylaws. The L.A. may, and if required by the Minister shall, make bylaws with respect to houses which are occupied, or are of a type suitable for occupation, by persons of the working classes. The operation of any such bylaws may be limited to houses let in lodgings or occupied by members of more than one family.

The bylaws may, *inter alia,* provide for the registration and inspection of such houses and for the prevention of nuisances in a part of a building or in an underground room subject to a closing order; and may prohibit the letting for occupation by members of more than one family of any such house unless the bylaws are complied with. If any person has failed to execute works required under these bylaws, the L.A. may, after twenty-one days' notice in writing, themselves execute the works and recover expenses.

The **Model Bylaws** (xiii, 1935) require :—

(1) Every owner of a house shall provide

(*a*) closet accommodation;

(*b*) a supply of water for domestic use;

(*c*) accommodation for washing clothes;

(*d*) accommodation for the storage of food in a reasonably cool position with proper ventilation from the external air wherever practicable and with protection from dust and flies;

(*e*) accommodation for the preparation and cooking of food;

adequate for the use of and readily accessible to the persons living in the house.

(2) Every owner shall

(*a*) keep drains, closets, sinks and baths in good repair;

(*b*) provide every tap with efficient means for carrying off waste water;

(*c*) provide every habitable room with a window or windows opening directly into the external air of a total area at least one-tenth of the floor area or, if there is more than one window and they are not situated in the same wall of the room, of a total area of at least one-twelfth of the floor area; each window being capable of being opened at the top to at least one-third of its extent;

(*d*) provide every habitable room with a flue or with an aperture or air shaft having an unobstructed sectional area of at least 30 square inches;

(*e*) provide every closet with efficient means of ventilation directly into the external air and, except where the closet is entered directly from the external air, with a window of an area of not less than 2 square feet opening where practicable directly into the external air;

(*f*) provide every bathroom, place where cooking apparatus is fixed and every passage and staircase with adequate means of ventilation and where practicable every staircase with adequate means of natural lighting;

(g) keep every staircase in good repair and, where necessary, provide a sufficient handrail.

(3) Every owner shall, where the internal surface or covering of any wall or ceiling or of any woodwork is in an unwholesome condition, cause such surface to be so treated that this condition shall be remedied.

(4) When a closing order is in force prohibiting the use of a part of a building or of an underground room for any purpose other than one approved by the L.A., the occupier shall keep the room clean and wholesome so as to prevent nuisance and, if necessary, the owner shall strip off all unclean or unwholesome paper and remove any woodwork infested with vermin or affected by wet or dry rot.

N.B. "Occupier" means the person in occupation of or having the management of a house or part of a house. "Owner" has the same meaning as in the Public Health Act (see p. 545).

The Model bylaws relating to houses let in lodgings (xiii b, 1935) are similar to the foregoing but include the following :—

(1) The occupier shall when so required in writing inform the L.A. of the total number of rooms in the house, the manner of use of each room, the name and address of the owner of the house, the number and nature of the sanitary, etc., fittings, the number of rooms let in lodgings, and the name of the person to whom each room is let.

(2) Every occupier shall keep clean such parts of the building and such fittings as are used in common by the lodgers and shall cleanse each room at the termination of the letting.

(3) Every lodger must remove all filth from his room before 2 p.m. each day and must keep clean his beds and bedding and such parts of the building and such receptacles as he has for his exclusive use.

(4) Every occupier must once a year cleanse thoroughly every part of the premises and, where the internal surface of a wall or ceiling or of any woodwork is in an unwholesome condition, the owner of the house shall cause such surface to be so treated that this condition shall be remedied.

(5) Right of entry for duly authorised officer of L.A. at all reasonable times.

Repair, demolition and closing of insanitary houses. When a L.A., on consideration of an official representation of the M.O.H. or otherwise, are satisfied that any dwelling-house occupied, or suitable for occupation, by persons of the working classes is unfit for human habitation, and is capable of being

made fit *at a reasonable expense,* they shall serve a notice on the owner requiring him within a reasonable time, not less than twenty-one days, to execute the work specified in the notice. In default, the L.A. may do the work themselves and recover expenses in court. The L.A. may by order declare any such expenses to be payable by weekly or other instalments over a period not exceeding thirty years.

When a L.A., on the other hand, decide that such house cannot be made fit at a reasonable expense, they shall serve a notice upon the persons having control of the house, the owner and any mortgagees, informing them of the time and place at which the condition of the house and any offer made by them as to the carrying out of works or the future user of the house will be considered. Any of the persons concerned will be entitled to be heard. If any of the persons upon whom notice is served intends to submit an offer to carry out repairs, he must, within twenty-one days of the service of the notice upon him, intimate in writing to the L.A. his intention to make such an offer and shall, within such time as the L.A. may allow, submit to the L.A. a list of the works he offers to carry out. The L.A. may decide to accept an undertaking from the owner or mortgagee that he will within a specified period carry out such specified works as will render the house fit, or that the house will not be used for human habitation without the consent of the L.A. If no such undertaking is accepted by the L.A., the L.A. must make a **demolition order** requiring that the house shall be vacated within not less than twenty-eight days from the date on which the order becomes operative, and that it shall be demolished within six weeks after the date on which it is vacated.

A L.A. may take the same proceedings in the case of any part of a building which is occupied, or is of a type suitable for occupation, by persons of the working classes, or in the case of any **underground room** which is deemed to be unfit for human habitation, as they may take in relation to a dwelling-house, with this exception, however, that where they would have made a demolition order they must make a **closing order** prohibiting the use of the part of the building for any purpose other than a purpose approved by the L.A. It should be noted that a L.A.'s bylaws may include a bylaw for the prevention of nuisances arising in a part of a building subject to a closing order.

A room, the floor of which is more than 3 feet below the surface of the part of the street adjoining or nearest to the room, or more than 3 feet below the surface of any ground within 9 feet of the room, is to be deemed unfit for human habitation if the room either (*a*) is not on an average at least 7 feet in height, or (*b*) does not comply with such regulations as the L.A., with

the consent of the Minister, may make for securing the proper ventilation and lighting of such rooms and their protection against dampness, effluvia or exhalation.

Model regulations prescribe :—

(*a*) Drainage of subsoil of the site, site to be covered by 6-inch cement concrete, adequate sub-floor ventilation, and any soil drain passing under the room to be gas-tight ;

(*b*) horizontal damp-proof course, and, if earth is in contact with the wall, a vertical damp-proof course or a hollow wall ;

(*c*) special ventilation openings in the absence of a fireplace and flue ;

(*d*) on effectually drained area extending throughout the entire length of one side of the room (alternative arrangements are laid down in the regulations) ;

(*e*) one or more windows which, clear of the frames, measure at least one-eighth of the floor area ; one-half of the window must open and the opening must extend to the top.

Back-to-back houses. It shall not be lawful to erect any back-to-back houses intended to be used as dwellings for the working classes and any such house shall be deemed to be unfit for human habitation ; provided that nothing shall prevent the erection or use of a house containing back-to-back tenements if the M.O.H. certifies that the tenements are so arranged as to secure effective ventilation of all habitable rooms. This section applies to any house commenced to be erected after 3 December, 1909.

Caravans and other movable shelters. Those portions of the Act which deal with repair or demolition of insanitary houses apply to any hut, tent, caravan or other temporary or movable form of shelter which is used for human habitation and has been in the same enclosure for a period of two years (see also pp. 544 and 573).

Verminous buildings. A L.A. may after notice in writing to the owner enter and cleanse from vermin any building to which a clearance order or a demolition order applies before such building is demolished.

Appeals. Any person aggrieved in respect of any notice, demand or order in relation to an insanitary house may appeal, within twenty-one days after the date of service, to the county court, provided that no question may be raised in such appeal regarding recovery of expenses incurred by a L.A. in executing works in default which might have been raised in an appeal against the original notice requiring the execution of the works. Where the judge allows an appeal against a notice requiring the execution of works to a dwelling-house, he shall if requested by

the L.A. include in his judgment a finding whether the house can or cannot be rendered fit at a reasonable expense. If the judge in allowing such an appeal has found that the house cannot be rendered fit at a reasonable expense, the L.A. may purchase the house by agreement, or may be authorised to purchase it compulsorily, and if they purchase the house compulsorily, they must forthwith execute all works specified in their own notice. The compensation to be paid for a house purchased compulsorily is the value of the site as a cleared site available for development according to the building bylaws. The L.A. may make allowances to certain persons displaced (see p. 629).

Clearance and re-development

Clearance areas. When a L.A., on consideration of an official representation from the M.O.H. or otherwise, are satisfied (1) that the dwelling-houses in the area concerned are by reason of disrepair or sanitary defects unfit for human habitation, or are by reason of their bad arrangement, or the narrowness or bad arrangement of the streets, dangerous or injurious to the health of the inhabitants of the area, and (2) that the most satisfactory method of dealing with the conditions in the area is the demolition of *all* the buildings in the area, the L.A. shall have the area defined on a map, excluding any building not unfit, and shall declare the area to be a *clearance area.* Before passing this resolution the L.A. must satisfy themselves that suitable accommodation will be available in advance for the persons displaced. A copy of the resolution must be sent to the Minister together with a statement giving the number of working-class persons occupying the area on a specified day.

The L.A. must as soon as possible either order the demolition of the buildings in the area (such clearance order must be confirmed by the Minister) or purchase the land and themselves secure the demolition of the buildings. A public local inquiry is always held by the Minister. Under a clearance order the date on which the buildings must be vacated is fixed and within six weeks of such date the owner must demolish the buildings. In default the L.A. must themselves undertake the demolition, sell the materials and recover any additional expenses in the county court. If the L.A. purchase the area they may either keep the land or dispose of it as they think fit. It should be noted that a L.A. may purchase also any land which is surrounded by a clearance area or which adjoins such area the acquisition of which is necessary for the satisfactory development of the cleared area.

Re-development of urban areas. An urban L.A. if satisfied that their district comprises any area in which the following conditions exist must define such area on a map and declare it by resolution to be a proposed re-development area :—

(*a*) that the area contains fifty or more working-class houses ;
(*b*) that at least one-third of the working-class houses in the area are overcrowded or unfit for human habitation and not capable at reasonable expense of being rendered fit, or are so arranged as to be congested ;
(*c*) that the industrial and social conditions of the local authority's district are such that the area should be used to a substantial extent for housing the working classes ; and
(*d*) that it is expedient in connection with the provision of housing accommodation that the area should be re-developed as a whole.

Such an area should include all the property within a continuous line on the map. It may include properties which it is not proposed to interfere with in any way. Notice of the resolution must be advertised locally and the map and a copy of the resolution must be sent to the Minister. Within six months after passing the resolution the L.A. must prepare and submit to the Minister a re-development plan for the area. If objections are made to the plan the Minister must hold a public local inquiry. In any event the Minister's approval is necessary. Suitable accommodation must be provided by the L.A. for all persons displaced from working-class houses as the re-development proceeds.

Compensation must be paid by a L.A. in respect of all properties purchased under clearance or re-development schemes. Where land is acquired compulsorily in a clearance area the basis of compensation is the value of the land as a site cleared of buildings and available for development in accordance with the requirements of the building bylaws of the district. In the case of compulsory purchase of land surrounded by a clearance area or adjoining a clearance area and required for opening out the area, the L.A. must pay compensation on the basis of the amount which the land, if sold in the open market by a willing seller, might be expected to realise.

In the case of a house which, though unfit for habitation and properly included in a clearance order or in a compulsory purchase order, has been well-maintained the L.A., if the Minister so directs, must make a special payment to the owner.

Allowances towards cost of removal, etc. A L.A. may pay a reasonable allowance towards the removal expenses of any person displaced under a clearance, demolition or closing order, and also a reasonable allowance to any person carrying on a trade or business who is similarly displaced and suffers loss in consequence. An allowance may also be paid to a retail shopkeeper in the neighbourhood of a clearance area who can satisfy

the L.A. that as a result of the diminution of the population of the locality he has suffered loss involving personal hardship.

Re-development and re-conditioning by owners. Owners may submit to the L.A. a scheme for the re-development of their property. If the scheme is approved and the work is being carried out within the specified time the L.A. are debarred during such time from dealing with the property under the provisions of this Act relating to single unfit houses, clearance or re-development schemes.

An owner may submit to the L.A. a list of works of structural alteration or improvement in respect of a dwelling-house occupied by, or of a type suitable for occupation by, persons of the working classes, and may request the L.A. to state if in their opinion the house as altered and with proper maintenance would remain fit for at least five years. If the owner carries out all the works required by the L.A., the L.A. must give him a certificate the possession of which by the owner will prevent his house, if properly maintained, being made the subject of a demolition or closing order or being included in a clearance order or in a compulsory purchase order to be purchased at site value during a period of not less than five or more than ten years.

"**Obstructive building**" means a building which, by reason only of its contact with, or proximity to, other buildings, is dangerous or injurious to health. The L.A. have power to order the demolition of such a building but must give all owners at least twenty-one days' notice of the time and place at which the question of demolition is to be considered. The L.A. may make a *demolition order* in respect of the whole or part of the building and the building must be vacated within two months of the date on which the order becomes operative. Within these two months the L.A. may purchase the building and must themselves in this case demolish it. Otherwise the owners must demolish the building within six weeks of the date on which it was vacated. The L.A. must compensate the owners.

Abatement of overcrowding

A dwelling-house shall be deemed for the purposes of this Act to be overcrowded at any time when the number of persons sleeping in the house either

(1) is such that any two persons, ten years old or more of opposite sexes not living together as husband and wife, must sleep in the same room ; or

(2) is, in relation to the number and floor area of the rooms, in excess of the following (whichever is the less) —

Number of rooms.

(*a*) One room	2	persons.
(*b*) Two rooms	3	,,
(*c*) Three rooms	5	,,
(*d*) Four rooms	7½	,,
(*e*) Five rooms or more	10,	with an additional 2 in respect of each room in excess of five.

N.B. A room of less than 50 square feet is not counted as a room.

Floor area of rooms.

(*a*) 110 square feet or more	2	persons
(*b*) 90 square feet or more, but less than 110 square feet	1½	,,
(*c*) 70 square feet or more, but less than 90 square feet	1	person
(*d*) 50 square feet or more, but less than 70 square feet	½	,,
(*e*) Under 50 square feet	*Nil.*	

No regard shall be had to any room having a floor area of less than 50 square feet. No account shall be taken of a child under one year of age and a child of one year but under ten years is reckoned as half a unit. These tables refer only to rooms which are normally used in the locality as living rooms or bedrooms.

It should be noted that L.A.'s providing housing accommodation for overcrowded persons who are displaced must in any replacement house belonging to themselves treat a house containing two bedrooms as providing accommodation for four persons, three bedrooms for five persons and four bedrooms for seven persons. Here children count as " whole persons whatever their age."

A two-storied house should have between 620 (minimum) and 950 (maximum) superficial feet and a flat between 550 and 880.

L.A.'s were required, before a date to be fixed by the Minister, to cause their districts to be inspected with a view to ascertaining what dwelling-houses were overcrowded. The results of the inspection had to be reported to the Minister as well as the number of new houses required to abate the overcrowding. The Minister may call for further similar reports in the future and the M.O.H. is required under the Sanitary Officers (Outside London) Regulations, 1935, to report annually to the Minister :—

(*a*) the number of dwellings overcrowded at the end of the year together with the number of families and the number of persons dwelling therein ;

(*b*) the number of new cases of overcrowding reported ;

(c) the number of cases of overcrowding relieved and the number of persons concerned ;

(d) particulars of any cases in which dwelling-houses, in respect of which the local authority have taken steps for the abatement of overcrowding, have again become overcrowded ;

(e) any other particulars with respect to conditions in relation to overcrowding upon which he may consider it desirable to report or which the Minister may from time to time require.

By 31st March, 1938, " appointed days " as from which it would become an offence to create new overcrowding had been fixed for every L.A. Such offence is punishable in the case of the occupier who causes it and the landlord who permits it by a fine not exceeding five pounds, with an additional fine not exceeding two pounds for each day on which the offence continues after conviction. Special exemption is given to occupiers who were in occupation on the appointed day and who have become overcrowded only as a result of children being born subsequent to the appointed day, provided they have not refused an offer of suitable alternative accommodation or have not declined to get rid of lodgers or sub-tenants. Similar protection is given also to an occupier whose family has become overcrowded as a result of increases in the ages of his children or as a result of a temporary visit from a member of his family not ordinarily resident in the house.

A landlord commits an offence (1) when, after being informed in writing that his tenant is overcrowded, he does not take steps to put an end to the overcrowding, including if necessary an application to the court for possession of the premises ; and (2) when, on letting a house, he had reasonable cause for believing that it would be overcrowded and did not inquire the number, age and sex of the intending occupants.

On the application of a L.A. the Minister may modify temporarily the overcrowding standard in any district, in the first instance for a period of not more than three years.

A L.A. may on the application of an occupier issue a licence permitting a dwelling-house to be occupied by a number of persons in excess of the permitted number. Such a licence cannot operate for more than twelve months and may be revoked at any time. An exceptional circumstance justifying the issue of such a licence might be a seasonal increase in the population (*e.g.* holiday resorts).

Every rent-book or similar document used in relation to a working-class house must contain a summary of the provisions of this Act relating to overcrowding in so far as they affect occupiers, as well as a note of the number of persons permitted

to occupy the house. If this information is not so provided the landlord is liable to a fine not exceeding ten pounds, and the occupier, if he fails to produce any rent-book under his control on being required to do so, is liable to a fine not exceeding two pounds. It is the duty of the L.A., upon the application of the landlord or the occupier of a dwelling-house, to inform the applicant in writing of the permitted number of persons who may occupy the house.

N.B. A "dwelling-house" is defined for the purposes of overcrowding as any premises used as a separate dwelling by members of the working classes or of a type suitable for such use. This definition would include a part of a building which is or is capable of being used as a separate dwelling. A "landlord" is the immediate landlord of an occupier and this means that the tenant of a whole house is the landlord of any sub-tenant occupying part of the house.

[By June, 1936, L.A.'s had surveyed 8,269,130 houses and found 3·8 per cent. to be overcrowded. The percentages in the different areas were: County of London, 7 per cent.; county boroughs, 4·1 per cent.; non-county boroughs, 2·8 per cent.; urban districts, 3·1 per cent.; and rural districts 2·9 per cent. In the Report on the Overcrowding Survey in England and Wales, 1936, it was shown that the worst overcrowding was found in the East End of London and in the north-east of England. Overcrowding was greater in local authorities' own houses than in privately owned houses (5·1 per cent. as compared with 3·7 per cent.). By the end of 1937 sixty-five authorities had completely abated the overcrowding in their districts and the number of cases remaining to be dealt with was 258,792, a decrease of practically one-quarter.]

Provision of houses

Every L.A. must periodically review the housing needs of their area and submit to the Minister, within three months if so required, proposals for the provision of new houses for the working classes.

A L.A. may provide such housing accommodation by the erection of new houses, by the conversion of buildings, by acquiring suitable houses and by altering or improving buildings. They may also supply any such house with all requisite furniture, fittings and conveniences. Under Sect. 80 they may provide and maintain buildings or land which, in the opinion of the Minister, would benefit the persons for whom they have provided housing accommodation. (It is under this power that several of the larger authorities have provided community centres or assembly halls on their estates. Extended powers are given in the Physical Training and Recreation Act, 1937, p. 639.)

A local authority or a county council may undertake to guarantee the repayment to a building society of any advances made by the society to any of its members for the purpose of enabling them to build or acquire houses. If the Minister approves such a proposal, he may undertake to re-imburse to the local authority or county council not more than one-half of any loss sustained by them. One of the conditions ordinarily imposed by the Minister is that the number of such houses should not exceed twelve to the acre and that each house should be provided with a fixed bath (Sect. 110).

Exchequer grants are now governed by the Housing (Financial Provisions) Act, 1938, and the Housing Acts (Review of Contributions) Order, 1942, and are payable in respect of:

(1) Housing accommodation for the re-housing of persons displaced as a result of demolition and closing orders, in pursuance of clearance and re-development operations and for the purpose of abating overcrowding. The Exchequer contribution is £5 10*s*. per house per annum for forty years. This may be increased to £6 10*s*. in county districts where the level of working-class rents is substantially below the average and the financial reserves of the district are small. Special provision is also made in respect of flats built on expensive sites, the Exchequer contribution being graded according to the cost of the site per acre and varying from £11 to £26 per flat per annum.

(2) Houses for members of the agricultural population (see p. 622 for definition), whether for persons displaced as a result of slum clearance, or for the purpose of abating overcrowding, or for general needs. Here the Exchequer contribution is £10 per house per year for forty years, increased in exceptional circumstances up to a maximum of £12 per year.

In all cases local authorities must make contributions from the rates in respect of these houses on the basis of half the Exchequer contribution, with this exception that their contribution in respect of houses provided for the agricultural population will be on the basis of only £1 per annum for forty years. The county council are required to make a similar payment in respect of houses for the agricultural population, and in respect of other houses in county districts towards which an increased contribution of £6 10*s*. is made by the Exchequer.

Management of local authorities' houses. Every L.A. must keep a **Housing Revenue Account** relating to all dwelling-houses for the working classes erected or acquired by the authority since 6th February, 1919, and it is intended that L.A.'s should be free to deal with their houses as a whole irrespective of any special conditions formerly laid down in particular Acts. In fixing rents the L.A. must take into

consideration the rents ordinarily payable by persons of the working classes in the locality and may grant to any tenant such rebates for rent as they may think fit. Rents must be reviewed from time to time and altered generally or in particular cases as circumstances may require. The L.A. must make it a term of every letting that the tenant shall not sub-let or otherwise part with the possession of any part of the premises except with the consent in writing of the L.A. During 1939 nearly 40 per cent. of local authorities' houses fell within a rent range of 6*s*. 1*d*. to 8*s*. a week (exclusive of rates) and 65 per cent. below 8*s*. 1*d*. In just over 6 per cent. the rent was below 4*s*.

A L.A. may set up a **Housing Management Commission** to whom they may transfer the management of all or any of their housing estates. The scheme must be approved by the Minister. Such a commission would be a permanent body making an annual payment to the L.A. for the property transferred to them and would be responsible for the letting and general maintenance of the houses. (There is evidence that a full-time manager trained on the Octavia Hill system can take charge of 300 houses.)

A L.A. may with the approval of the Minister arrange with a **Housing Association** to :—

(*a*) provide re-housing accommodation for persons displaced from unfit houses or by reason of re-development plans and abatement of overcrowding ;

(*b*) undertake the re-conditioning and management of houses acquired by the L.A.

The Public Works Loan Board may make advances to housing associations up to a maximum of 90 per cent. of the value of houses to be erected by them. A L.A. also may make grants or loans to such associations and may guarantee the payment of the principal of, and interest on, any money borrowed by the association.

A " housing association " means any society, body of trustees or company dealing with working-class houses which does not trade for profit or issue any capital with interest exceeding the rate for the time being prescribed by the Treasury. (The rate in 1940 was 5 per cent.)

Small Dwellings Acquisition Acts, 1899–1923 (together with Housing Act, 1936)

Local authorities may advance up to 90 per cent. of the market value of a house, the market value of which does not exceed £800, to enable the person resident in such house to acquire the ownership. Advances may also be made to a person intending to construct a house, provided he himself undertakes to reside in it, and to persons or bodies carrying out

repairs to houses. During 1938–39 the sum so advanced by local authorities in England amounted to £3,058,709.

Rural housing

Under the **Housing (Rural Workers) Acts, 1926–42,** as amended by the Housing Acts, county councils may aid financially the reconstruction and improvement of houses and other buildings to be used for occupation by agricultural workers. The completed value of the house must not exceed £400, and the work done must cost at least £50. Government grants are available up to an amount of two-thirds of the estimated cost of the works, or a maximum grant of £100 in respect of each dwelling. The rent payable must not exceed the normal agricultural workers' rent, with an addition equivalent to 4 per cent. of the cost of the works not covered by grant. The Minister of Health is prepared in suitable cases to place the administration of these Acts in the hands of rural district councils. Between 1926 and 1939 assistance of this nature was given in respect of 21,732 houses in England and Wales. These Acts expire on 30th September, 1945.

The Housing Act, 1936, requires that every county council must have constant regard to the housing conditions in the rural districts within the county, and every rural district council shall each year furnish to the C.C. such information regarding housing as the C.C. may require. A county council may by agreement with a rural district council exercise all or any of the powers of the district council in relation to the provision of houses for the working classes. The contributions from public funds towards the cost of rural housing have been noted on p. 634.

Power of entry, etc.

Any person authorised in writing stating the particular purpose for which entry is authorised may at all reasonable times on giving twenty-four hours' notice to the occupier and to the owner, if the owner is known, enter any house, premises or buildings for the purposes of this Act.

A L.A. may, for the purpose of enabling them to serve any notice, require the occupier of any premises and any person who, either directly or indirectly, receives rent in respect of any premises to state in writing the nature of his interest therein and the name and address of any other person known to him as having an interest therein.

Defaulting local authorities

The Minister may reduce the amount of any Exchequer contribution payable to a L.A. or suspend the payment of any contribution if he is satisfied that the L.A. have failed to

discharge any of the duties imposed on them by the Housing Act. Power is given to a county council to act in place of a defaulting rural district council, and the Minister may transfer to a county council the functions under this Act of a defaulting non-county borough or urban district council. The Minister may himself act in the place of a defaulting county council.

Central Housing Advisory Committee

The Minister must set up such a committee who will advise him on the desirability of modifying locally the overcrowding standard and on any matters relating to housing.

PLANNING

Town and Country Planning Act, 1932. This Act repealed all previous planning legislation and authorised the making of schemes with respect to any land, whether there are or are not buildings thereon, with the object of controlling the development of the land comprised in the scheme, of securing proper sanitary conditions, amenity and convenience, and of preserving existing buildings and other objects of architectural, historical or artistic interest and places of natural interest or beauty. Schemes may be prepared by any L.A. and by the L.C.C., and any district council may relinquish any of their powers under the Act in favour of the C.C. Two or more local authorities may act jointly in the preparation of a scheme by delegating to a joint committee all or any of the powers (other than the power to levy a rate). This provides for *regional planning*. If the Minister is satisfied after holding a local inquiry that a scheme ought to be prepared by an authority as respects any land, he may by order require the authority to prepare a scheme. In default, he may himself act in place of the authority or, in the case of smaller districts, empower the county council to act.

The first stage in the preparation of a scheme is for the L.A. to pass a resolution deciding to prepare a scheme. This resolution does not take effect until it has been approved by the Minister. Provision is made for the protection of the development of the land between this approval of the resolution and the coming into operation of the scheme. The scheme must deal with such matters as—

1. Roads, buildings and open spaces.
2. Prohibition, regulation and control of the disposal or deposit of waste materials and refuse.
3. Sewerage, drainage and sewage disposal.
4. Lighting and water supply.

And may—

(*a*) prescribe the space about buildings ;
(*b*) limit the number of buildings ;

(c) regulate the size, height, design and external appearance of buildings ;

(d) impose restrictions upon the manner in which buildings may be used, including the letting of dwelling-houses in separate tenements ;

(e) prohibit or regulate building operations.

Power is also given to require by notice the removal within not less than twenty-eight days of displayed advertisements or hoardings set up on land specified in a scheme as land to be protected in respect of advertisements if they appear seriously to injure the amenity of the land.

Provision is made for the payment in certain cases of compensation to owners whose property is very seriously affected by a scheme and the responsible authority in their turn are given the right to claim " betterment " up to 75 per cent. of the increased value which property may acquire as a result of the coming into operation of a scheme.

At 31st March, 1939, over 26 million acres of land, or more than one-half of England and Wales, were covered by planning resolutions or schemes, and at that date the total number of L.A.'s whose districts were wholly or partly subject to planning was 1,175.

The Minister of Town and Country Planning Act, 1943, provides for the appointment of a Minister of Town and Country Planning whose duty is to secure consistency and continuity in the framing and execution of a national policy for the use and development of land throughout England and Wales. To this Minister are transferred by Order in Council under the Act all the functions of the Town and Country Planning Act, 1932, expressly exercised by the Minister of Health and transferred from him to the Ministry of Works and Planning in 1942. The only powers under the 1932 Act not so transferred are those under Sects. 32, 51, and 55 relating to sums received by L.A's. in respect of betterment, compensation of officers, and special provisions in connection with Surrey C.C.

The Minister of Works Act, 1942, provides for the appointment of a Minister of Works to whom are to be transferred the functions and property of the Commissioners of Works and of the Commissioners of Public Works in Ireland.

The Town and Country Planning (Interim Development) Act, 1943, amends and extends the 1932 Act, it alters the procedure with regard to applications for interim development orders and makes other important modifications. The Ministry of Town and Country Planning Memorandum A., " General Notes on Planning Schemes and Detailed Comments on the revelant Acts," issued in October, 1943, is a useful guide and the two further memoranda on the subject at present being prepared should also be studied.

Under the **Restriction of Ribbon Development Act, 1935,** it is unlawful, without the consent of the highway authority, to erect any building (other than an agricultural building—not being a dwelling-house) within 220 feet of the middle of any classified road, or to make any new means of access to such a road.

See Min. of Works and Planning Report of the Committee on Land Utilisation in Rural Areas (Chairman, The Rt. Hon. Lord Justice Scott), 1942, and Final Report of Expert Committee on Compensation and Betterment (Chairman, The Hon. Mr. Justice Uthwatt), 1942.

PHYSICAL TRAINING AND RECREATION ACT, 1937

This Act established two National Advisory Councils for Physical Training and Recreation—one for England and Wales and the other for Scotland—to advise government on matters relating to the maintenance and improvement of the physical well-being of the people, means of exercise and recreation.

In England and Wales the Council must appoint local committees consisting of persons representing local education authorities for higher education and other local authorities, voluntary organisations and persons having special knowledge and experience.

The Board of Education may make grants (*a*) towards the expenses (other than maintenance expenses) of a local authority or local voluntary organisation in providing facilities for physical training and recreation, including gymnasiums, playing fields, swimming-baths, bathing places, holiday camps and camping sites and other premises ; (*b*) towards the expenses of a local authority or local voluntary organisation in respect of the training and supply of teachers and leaders ; and (*c*) to the funds of any national voluntary organisation having such objects.

A local authority may provide and equip, whether within or without their area, gymnasiums, playing fields, holiday camps or camping sites and may manage these premises themselves (with or without a charge for admission) or may let them, at a nominal or other rent, to any person, club or organisation for use for the purposes of the Act. The authority may also provide, and arrange for the training of, wardens, teachers and leaders and may contribute towards the expenses incurred by another local authority or by a voluntary organisation in providing a swimming-bath or bathing place on a site where it will benefit any of the inhabitants of their area.

A county council may provide swimming-baths and bathing places under Part VIII. of the P.H.A., 1936.

Local education authorities for higher education are given

power to extend schemes for the promotion of social and physical training to persons of any age.

The Board of Education may provide and maintain one or more National Colleges of Physical Training for England and Wales.

"Local authority" means the council of a county, county borough, metropolitan borough, county district or parish.

(See Memo. on the powers of local authorities under the Physical Training and Recreation Act, 1937—issued July, 1937.)

INTERNATIONAL HYGIENE AND PORT WORK

The two international bodies established by agreement between Governments are :—

1. The *Office International d'Hygiène publique,* in Paris, established by the Rome Convention, 1907. It was set up to deal especially with international control of infectious disease. Practically every country in the world is now represented on the permanent committee of delegates which, normally, meets twice a year in Paris. The Office is responsible for drafting international agreements and for carrying out various epidemiological studies.

2. The Health Organisation of the League of Nations, established under Article 23 of the Covenant of the League for the purpose of taking steps in matters of international concern for the prevention and control of disease. A Health Section of the Secretariat was created in 1921 under a Health Committee of the League. The work done by this body has been of a varied character, and includes co-operation with various Governments in health work, provision of an intelligence service, and the holding of " interchanges " of technical officers and study tours.

International agreements

1. *International Sanitary Convention,* 1926. Takes the place of earlier conventions of a similar character, the first of which was the Dresden Convention, 1893. The Convention aims at the standardisation of procedure in the countries of the various signatory Governments in regard to the prevention of the introduction of infectious disease by sea or by land. So far as England and Wales are concerned, the Convention has been given effect to in the Port Sanitary Regulations, 1933.

The principal provisions of the Convention deal with (1) the intercommunication between the various countries of information relating to outbreaks of smallpox, typhus, cholera, plague and yellow fever.

(2) Avoidance of unnecessary interference with passengers, merchandise and mails. The circumstances justifying " observation " (detention) or " surveillance " (liberty under super-

vision) of travellers are defined, as are also the conditions justifying detention, disinfection and deratisation of ships. Each " Convention " disease is dealt with separately.

(3) Regulation of the sanitary control of the Mecca pilgrimage. This deals with the prevention of cholera and other epidemic diseases, the measures to be taken before the departure of pilgrim ships, during the voyage, and on arrival in the Red Sea, the accommodation, food, water supply, latrines, hospital quarters and medical staff to be provided on pilgrim ships, and the measures to be taken in respect of pilgrims returning home. Pilgrim ships coming from the south and bound for the Hedjaz must in the first instance put in at the sanitary station at Kamaran and be subjected to the procedure set out in the Convention, and those coming from the north of Port Said and going to the Hedjaz are dealt with in a similar manner at Tor.

2. *International Sanitary Convention for Aerial Navigation* (The Hague, 1933). The principal provisions of this Convention have reference to the measures regarded as necessary for the prevention of spread by air of yellow fever from West Africa to East Africa and India, although the other four " Convention " diseases are also dealt with and sanitary regulations generally applicable to aerial navigation are included (see p. 115). Effect has been given to this Convention in the United Kingdom by the P.H. (Aircraft) Regs., 1938 (p. 649). War-time modifications are noted on p. 115.

3. *International Convention for Mutual Protection against Dengue Fever*. This deals with the notification of dengue fever in epidemic form, the destruction of mosquitoes on ships, the isolation of patients, medical inspection of passengers coming from an infected port, the inspection of ships and the procedure to be adopted at land frontiers bordering on a territory where dengue has broken out in epidemic form.

4. *International Agreement for the Treatment of Venereal Disease in the Mercantile Marine* (Brussels, 1924). The signatory Governments agree to provide modern diagnosis and treatment at specified ports free of charge to seamen and to supply seamen with personal record cards of an approved pattern on which all entries relating to treatment, etc., may be made.

5. *International Agreement for Unification of Pharmacopœial Formulas for Potent Drugs* (Brussels, 1929). This agreement provides for the acceptance of an international list of potent drugs, for comparison of methods of testing and for the establishment of a permanent international secretariat for dealing with future requirements.

6. *Fifth Decennial International List of Causes of Death*. An International Conference recommended in 1929 that there should be three official lists of causes of death : (1) a detailed

list of 200 causes; (2) an intermediate list of eighty-five causes and (3) a short list of forty-three causes, and that it should be left to each country to adopt the appropriate official list. International lists have been prepared which, it has been agreed, will be revised decennially.

Port health authorities

The duties of a port health authority (see p. 525) include—

1. The prevention of the importation of infectious disease.
2. The prevention of the importation of rat plague.
3. The carrying out of the provisions of the International Sanitary Convention, 1926, as embodied now in large part in the Port Sanitary Regulations, 1933.
4. Supervision of the hygiene of crew and passenger accommodation in ships.
5. Inspection of imported food (see p. 601).
6. Miscellaneous duties such as inspection of canal boats, control of shellfish layings, smoke abatement and supervision of the general sanitary condition of the district.

An annual Exchequer grant amounting to 50 per cent. of approved net expenditure is paid in respect of port health work.

The Port Sanitary Regulations, 1933

Definitions

"Foreign-going ship" means a ship employed in trading or going between some place in Great Britain and Northern Ireland and some place situate beyond the coasts of Great Britain and Ireland, the Channel Islands, the Isle of Man or the Continent of Europe between the River Elbe and Brest inclusive;

"Approved port" means a district in which a medical officer is authorised by the Minister to grant deratisation certificates and deratisation exemption certificates;

"Suitably equipped port" in relation to any disease means a port which has been notified to the *Office International d'Hygiène publique* as possessing the necessary organisation and equipment for dealing with that disease;

An "infected" ship means a ship

(*a*) which has on board a case of plague, cholera or yellow fever; or

(*b*) on which a person developed plague more than six days after embarkation and which has not since been subjected to the prescribed measures; or

(*c*) on which plague-infected rats are found; or

(*d*) which has had on board a case of cholera within five days prior to arrival and which has not since been subjected to the prescribed measures; or

(e) which had on board a case of yellow fever at the time of departure from a port, or which has had such a case on board during the voyage and which has not since the last case occurred been subjected to the prescribed measures.

A " suspected " ship means a ship

(a) on which a person developed plague within six days after embarkation and which has not since been subjected to the prescribed measures ; or

(b) on which there has been an unusual mortality among rats the cause whereof is undetermined ; or

(c) which had on board a case of cholera at the time of departure from a port or during the voyage but on which no fresh case has occurred within five days prior to arrival and which has not since the last case occurred been subjected to the prescribed measures ; or

(d) arriving from a port or seaboard included by reason of yellow fever in the list of infected ports and seaboards kept by the medical officer as prescribed by these regulations or from a port or seaboard in close relation with an endemic centre of yellow fever after a voyage of less than six days or after a longer voyage if there is reason to believe that the ship may be carrying adult mosquitoes emanating from the said port or seaboard :

Provided that for the purpose of the definitions of " infected " and " suspected " a case presenting the clinical features of cholera shall be deemed to be a case of cholera until two bacteriological examinations made with an interval of not less than twenty-four hours between them have not revealed the presence of cholera or other suspicious vibrios.

" Infectious disease " means any epidemic or acute infectious disease but does not include venereal disease ;

" Deratisation certificate " and " deratisation exemption certificate " mean respectively a deratisation certificate and a deratisation exemption certificate at a port which has been notified to the *Office International d'Hygiène publique* as possessing the equipment and personnel necessary for the deratisation of ships ;

" Valid " in relation to a certificate means issued within the last preceding six months or, where the ship in respect of which the certificate is issued is proceeding to its home port, within the last preceding seven months.

Ships arriving

The master of a foreign-going ship approaching a district from a foreign port must send a wireless message if there are any circumstances requiring the attention of the port medical officer. Such message should reach the port sanitary authority

not more than twelve and not less than four hours before the expected time of arrival of the ship. In any event the sanitary authority must, where necessary, be notified of the health conditions on board the ship forthwith on its arrival and must in their turn at once notify the customs officer.

In every district one or more mooring stations must be established where a ship can be moored without coming into contact with other ships or the shore.

The port medical officer must keep an up-to-date list of foreign ports and seaboards which are believed to be infected with plague (human or rodent), cholera, yellow fever, typhus fever or smallpox, and must supply copies to the pilots and customs officers employed in the district.

Infected or suspected ships and other ships which may be unhealthy :—1. In any of the cases hereinafter specified the master of a ship arriving in a district shall cause the ship to be taken to a mooring station unless the port medical officer otherwise directs, that is to say where—

(*a*) the ship is an infected or suspected ship or has a case of typhus fever or smallpox on board ; or

(*b*) during the voyage (or where the voyage has lasted more than six weeks, during the last six weeks)—

(i.) there has been on the ship a case or suspected case of plague, cholera, yellow fever, typhus fever or smallpox ; or

(ii.) plague has occurred or been suspected amongst rats or mice on the ship ; or

(iii.) sickness or death not attributable to poison or the employment of other measures for destruction has occurred amongst the rats or mice on the ship ;

and the ship has not since any such condition supervened been subjected to the prescribed measures.

2. The master shall also cause the ship to be taken to a mooring station if the medical officer so directs.

3. The ship shall remain subject to control under these regulations until it has been examined by the medical officer and until any measures which may be required to be carried out have been completed.

Declarations of health. The master of a foreign-going ship arriving from a foreign port must fill in and sign a declaration of health in a special form and the ship's surgeon must countersign the declaration. This declaration must be delivered either to the customs officer or the officer of the port health authority who shall forward it to the port health authority.

Detention, etc., of ships. When a ship arrives from a foreign port the customs officer may direct the ship to be moored at a special mooring station, unless the medical officer otherwise

allows, if it appears to him that there has been during the voyage a death from illness suspected to be of an infectious nature or a case of such illness, or that the ship has called at an infected port, or that plague has occurred or been suspected amongst rats or mice in the ship. The medical officer may also direct that a ship arriving from a foreign port shall be detained for medical examination and may hand a notice in writing to that effect to the customs officer who, if he is the first officer to visit the ship, shall deliver the notice to the master ; but a ship detained in this manner by the medical officer is usually allowed to proceed to its place of discharging or loading and the medical officer must visit the ship as soon as possible.

The detention of any ship by a customs officer shall cease as soon as the ship has been duly visited and examined by the medical officer or, if the examination has not commenced within twelve hours after the ship has been moored, on the expiration of that period.

When a ship arrives from a foreign port no person except an official may board or leave the ship without the permission of the port medical officer until the ship is free from control under these regulations and the medical officer, before granting permission, may require any person to state his name and his intended destination and address and to give any other reasonable information for transmission to the local authority of the area within which the intended place of destination of the person is situate. If such a person either is unable to state his intended destination or address or arrives, within a period not exceeding fourteen days after landing, at a place other than that he has so stated he shall immediately after his arrival forward particulars of his actual place of arrival and his address to the medical officer of the district in which he left the ship.

When a ship arrives from a foreign infected port the medical officer shall inspect it, provided that a ship shall not be deemed to have called at a foreign port if, without having been in communication with the shore, it has landed only mails and passengers and their luggage, or it has taken on board only mails or passengers with or without their luggage from another ship which has also not been in communication with the shore. The medical officer must also inspect a ship from a foreign infected port within twelve hours after it has arrived at a mooring station or after detention by a customs officer and, if there is suspicion of plague-infected rats, he must cause all practicable steps to be taken to prevent the escape of rats from the ship.

If plague-infected rats are discovered, or plague, cholera, yellow fever, typhus fever or smallpox occurs, on any ship after it has come into a district the medical officer may require the master to remove the ship to a mooring station.

Deratisation and deratisation exemption certificates. On the arrival of a ship from a foreign port at an approved port, whether or not the first port of call in England or Wales, the medical officer shall, unless a valid deratisation certificate or valid deratisation exemption certificate is produced in respect of the ship, take such steps as he may consider necessary to ascertain whether the ship is maintained in such a condition that the number of rats on board is kept down to the minimum.

The medical officer either (*a*) may sign and issue a deratisation exemption certificate, or (*b*) shall require the ship to be deratised in such manner as may be specified or approved by him.

Upon receipt of an application in writing from the owner or master of any ship in an approved port for a deratisation exemption certificate or a deratisation certificate in respect of the ship, the medical officer shall satisfy himself that the ship is maintained in such a condition that the number of rats on board is kept down to the minimum, or give directions for the deratisation of the ship, as the case may require.

A copy of every such certificate shall be retained in the office of the health authority, and a copy shall be forwarded to the Minister unless he otherwise directs.

The owner or the master of the ship shall pay to the sanitary authority such fee for the inspection of the ship and for the issue of a certificate as the Minister may from time to time determine.

Ships in port

Embarkation of persons. 1. The medical officer may examine any person proposing to embark on a ship whom he suspects to be suffering from plague, cholera, yellow fever, typhus fever or smallpox and if, after examination, he is of opinion that the person shows symptoms of any of these diseases he may prohibit his embarkation.

2. If severe smallpox (variola major) exists in any part of Great Britain, the medical officer may prohibit any person coming from such part who has been in contact with any person suffering from the disease and who is not, in the opinion of the medical officer, adequately protected against smallpox, from embarking on any ship going beyond Great Britain, Ireland, the Channel Islands and the Isle of Man.

Examination of ships and persons on board. 1. The medical officer may at any time, and shall within twelve hours after receiving a request from the master so to do, visit any ship and may medically examine any person on board or proposing to embark on the ship.

2. The medical officer may examine any clothing, bedding or other personal article intended for use by a member of the crew

or by any person who proposes to embark on or is on board any ship, and may require its disinfection or destruction.

3. The medical officer may require any parts of a ship to be disinfected to his satisfaction.

Plague, cholera and typhus fever. If any part of the district is declared to be infected with plague, the medical officer may take steps to secure the deratisation of any ship in which he has reason to believe that there are rats and require the master of the ship to take steps to prevent the access of rats from the shore to the ship. If any part of the district is declared to be infected with cholera, the medical officer may (*a*) order all drinking-water tanks and filters on a ship to be emptied, cleansed and disinfected and refilled with wholesome water ; (*b*) prohibit any person from taking foodstuffs on board a ship (this provision may apply to all foodstuffs or to any specified foodstuffs or any class of foodstuff or to foodstuffs obtained from any specified source), and (*c*) require the disinfection of bilges and any water used as ballast.

If typhus fever is declared to exist in epidemic form in any part of the district, the medical officer may require any person who proposes to embark or is on board any ship to be deloused.

General

The port health authority may for the purposes of these regulations, and if so required by the Minister shall,

(*a*) appoint medical officers and pay them such salaries as the Minister may approve ;

(*b*) assign duties to the various medical officers provided that only the medical officer of health or his deputy may sign and issue certificates and statements ;

(*c*) provide or arrange for the provision of—

- (i.) premises and waiting-rooms for the purposes of medical examinations ;
- (ii.) apparatus or means for the cleansing and disinfection of ships, persons and clothing and other articles ;
- (iii.) premises for the temporary accommodation of persons for whom such accommodation is required for the purposes of these regulations ;
- (iv.) hospital accommodation for persons to whom these regulations are applicable ;
- (v.) means of transport.

Powers and duties of medical officers. 1. For the purposes of these regulations the medical officer or any duly authorised officer of the port health authority shall have power to enter or board any ship in the district and may cause the ship to be

moored in some safe and convenient place while it is visited and examined.

2. The medical officer may—

(*a*) examine any person who is suffering from infectious disease on board a ship in the district;

(*b*) examine any person who is on board such a ship, where there are reasonable grounds for believing or suspecting that infectious disease is or may be present on the ship, or that persons on board the ship have been exposed to infection from infectious disease during the voyage of the ship or during a period of three weeks immediately preceding the arrival of the ship in the district;

(*c*) examine any person who is on board a ship in the district and is reasonably believed to be verminous;

(*d*) detain for the purpose of examination either upon the ship or at some appointed place on shore any person whom he is empowered or required to examine.

3. (*a*) The medical officer may cause any person who is on board a ship in the district and who appears to be suffering from infectious disease to be removed, if his condition so permits, to some hospital or other suitable place appointed for that purpose by the port health authority.

(*b*) If the condition of any such person does not permit of his removal, the medical officer may, by notice in writing to the master, prohibit the removal of the person or his departure from the ship, save with the consent in writing of the medical officer.

Duties of master. The master of a ship in a district shall—

(*a*) furnish the port health authority and their officers with all such information and assistance as may be reasonably required by them for the purposes of these regulations;

(*b*) notify forthwith the medical officer of any case of infectious disease on the ship and of any circumstances on board which are likely to lead to infection or the spread of infectious disease, including in his notification particulars as to the sanitary condition of the ship and the presence of dead rats or mortality or sickness among rats in the ship;

(*c*) comply with these regulations and any directions or requirements of the port health authority or the medical officer.

Cleansing, etc., of ships. By an extension of Article 3 of the Port Sanitary Authorities (Assignment of Powers) Order, 1912, the port health authority may notify a master that the cleansing and disinfection of any part of his ship will be carried out by the port health authority at his cost unless the master informs the port health authority within six hours of the receipt of the notice that he will forthwith do the work to the satisfaction of the medical officer.

At the request of the master and, if thought fit, at his cost, the port health authority may carry out any measures required under these regulations. The amount of the charge for the work may have to be deposited with the port health authority before the work is undertaken.

N.B. No power is given in the regulations to detain, disinfect or destroy any article forming part of any mail, and a master of a ship who does not desire to submit to any requirements of these regulations is at liberty to put to sea without being subjected to control under the regulations if he notifies the medical officer of his intention. The port medical officer may, however, permit him, upon conditions in conformity with the provisions of the International Sanitary Convention, 1926, to land goods, to disembark passengers, or to take on fuel, foodstuffs or water.

The **Schedules** to the regulations describe (*a*) the flags and signal lights to be used by ships, (*b*) the measures to be carried out in respect of an infected or suspected ship or of a ship with a case of typhus fever or smallpox on board, and (*c*) the form of declaration of health.

Public Health (Aircraft) Regulations, 1938

These Regulations resemble the Port Sanitary Regulations, 1933, and were made in conformity with the International Sanitary Convention for Aerial Navigation. The authorities responsible for their execution are county councils (but only as respects aerodromes maintained by them), port health authorities and local health authorities.

Two types of aerodrome are recognised—" customs aerodromes " and " sanitary aerodromes." At the latter type the following must be available :—

(*a*) an organised medical service with a medical officer and at least one assistant officer acting under his direction ;

(*b*) a place for medical inspection ;

(*c*) either a laboratory for the examination of suspected material or equipment for taking and despatching such material for examination in a laboratory ;

(*d*) facilities for the isolation, transport and care of the sick, for the isolation of contacts separately from the sick and for carrying out any other prophylactic measure in suitable premises either within the aerodrome or in proximity to it ;

(*e*) the apparatus necessary for carrying out disinfection, disinsectisation, deratisation and any other measures prescribed by these regulations ;

(*f*) a sufficient supply of wholesome drinking water ; and

(*g*) a proper and safe system for the disposal of excreta and refuse, and for the removal of waste water.

A sanitary aerodrome must be as far as possible protected from rats.

The medical officer will be the medical officer of health or a practitioner acting under him. It is not of course necessary that all the premises, equipment and other facilities should be provided actually on the site of the aerodrome, though they must be readily accessible to it. Thus the authority's own isolation hospital will probably be utilised as well as some existing disinfecting station. The powers of the medical officer include medical examination, and if necessary detention and isolation, of persons arriving by aircraft. He may also direct aircraft, arriving at a customs aerodrome, to proceed to a sanitary aerodrome if special sanitary measures have to be applied.

Finally the Regulations lay down a procedure to be followed in respect of infected aircraft or aircraft coming from an infected locality—as regards plague, cholera, typhus fever and smallpox.

The *International Sanitary Convention for Aerial Navigation* deals extensively with yellow fever and defines an "anti-amaryl" aerodrome as being not only a "sanitary aerodrome" but also—

(1) situated at an adequate distance from the nearest inhabited centre;
(2) provided with arrangements for a water supply completely protected against mosquitoes and kept as free as possible from mosquitoes by systematic measures for the suppression of breeding places and the destruction of the insects in all stages of development;
(3) provided with mosquito-proof dwellings for the crews of aircraft and for the staff of the aerodrome; and
(4) provided with a mosquito-proof dwelling in which passengers can be accommodated and hospitalised if necessary.

See also p. 115.

Parrots (Prohibition of Import) Regulations, 1930

These regulations were issued on account of the occurrence of cases of psittacosis in England and Wales, and prohibit importation of parrots except those required for the purposes of medical or veterinary research and those consigned to the Zoological Society of London or to persons specially authorised by the Min. of H. to import parrots otherwise than for sale. "Parrot" includes lovebirds, macaws, cockatoos, lories, lorikeets, etc. (Annual Report, C.M.O., Ministry of Health, 1933, p. 50.)

Aliens Order, 1920

The Home Office is responsible for the exclusion of any alien from this country, and all aliens, whether first-class passengers or not, are liable to exclusion for medical or other reasons. The Min. of H. is responsible for the arrangements for medical inspection, and the port medical officer is the supervising official at each port approved for the landing of aliens. Medical certificates are given in respect of persons suffering from defects or deformities which might interfere with the capacity of the alien to support himself and his dependants.

SOCIAL INSURANCE

In Great Britain various forms of social insurance are provided under the Old Age Pensions Act, the National Health Insurance and Contributory Pensions Acts and the Unemployment Insurance Acts. The Workmen's Compensation Acts, under which an employer is liable to pay compensation for personal injury by accidents (and certain scheduled diseases) arising out of and in the course of his workpeople's employment, do not provide for any system of compulsory insurance against these risks (see p. 146).

Old age pensions. The present law relating to non-contributory old age pensions is contained in the Old Age Pensions Act, 1936. The Old Age Pensions Act, 1908, gave British subjects of seventy years of age, resident in the United Kingdom, the right to a pension of a maximum amount of 5*s*. weekly, provided they were not in receipt of incomes of more than £31 10*s*. a year. There were certain disqualifications, such as receipt of poor law relief (other than medical) and imprisonment during the preceding ten years. Subsequent legislation has removed most of the disqualifications, has increased pensions to 10*s*. weekly (where the calculated yearly means of the person do not exceed £26 5*s*.), and has introduced contributory pensions payable at age 65 in the case of men and 60 in the case of women. The minimum age for the award of a non-contributory pension is still 70, except in the case of blind persons who may be granted a pension at age 40. Payment of pensions is made at post offices, weekly in advance.

Contributory pensions. The Widows', Orphans' and Old Age Contributory Pensions Acts, 1936 to 1941, impose compulsory insurance of this nature on all persons aged 16 and upwards coming within the scope of the National Health Insurance Acts, 1936 to 1941. An insured person is entitled to a contributory pension of 10*s*. a week at the age of 65 (60 in the case of a woman) and at age 70 he becomes entitled to have this pension replaced, without further claim and without any conditions as to means, by a pension of similar amount

under the Old Age Pensions Act, 1936. Upon the death of an insured man his widow receives a widow's pension of 10*s*. a week until she attains the age of 70 (unless she remarries before that age) when it is replaced by a pension of a similar amount under the Old Age Pensions Act. Allowances are paid in respect of children up to the age of fourteen years, or sixteen if the child still attends school. These allowances are 5*s*. a week for the eldest child and 3*s*. a week for each of the others. Should the widow die, orphans' pensions are 7*s*. 6*d*. each a week. Pensions are not affected by the widow's possession of means or by her capacity to earn a living. The weekly pensions contributions paid in respect of insured persons are collected along with those for National Health Insurance, and amount in the case of men to 1*s*. 1*d*. (employer 6½*d*., employee 6½*d*.) and in the case of women to 8½*d*. (employer 3½*d*., employee 5*d*.). Anyone who has been in employment subject to compulsory health and pensions insurance for at least two years and ceases to be so employed may become a voluntary contributor under the Contributory Pensions Scheme and, except in the case of married women, under the Health Insurance Scheme. Voluntary contributors pay the whole of the contributions themselves and the rates are 1*s*. 1*d*. a week for men and 8½*d*. a week for women for pensions, and 11*d*. a week for men and 10½*d*. a week for women for health insurance. Under the Widows', Orphans' and Old Age Contributory Pensions (Voluntary Contributors) Act, 1937, voluntary insurance for pensions was extended to a large range of persons not covered by the main scheme and not qualified to become voluntary contributors by virtue of previous insurable employment. This special scheme came into operation in January, 1938, and to be eligible to join it an applicant must be under the age of 40, the total income must not exceed £400 a year in the case of men (£250 in the case of women), and he must have been continuously resident in the United Kingdom for ten years immediately before the date of application for admission to the scheme. During 1938 persons were admitted up to the age of 55 and the rates of contribution, regardless of age, were 1*s*. 3*d*. for men and 6*d*. for women, but from 1939 onwards the rates of contribution are graduated according to age at entry. The pension benefits for voluntary contributors are the same as those provided for ordinary insurable persons, but the minimum age for the award of old age pensions to men and women insured under the special scheme is 65.

Supplementary Pensions. Under the Old Age and Widows' Pensions Act, 1940, any person, whether man or woman, who has been granted an old age pension, and any widow pensioner aged 60 and upwards, may apply for a supplementary pension if in need of additional assistance. The Pensions and Determination of Needs Act, 1943, provides that supplementary

pensions may also be claimed by widows under 60 (with children) who are already receiving widows' pensions and children's allowances under the Contributory Pensions Scheme.

National health insurance. This scheme was established by the National Health Insurance Act, 1911, the preamble to which describes the Act as "an Act to provide for insurance against loss of health and the prevention and cure of sickness and for purposes incidental thereto." The law is now contained in the National Health Insurance Acts, 1936 to 1941. National health insurance is compulsory upon all persons, male or female, at the age of fourteen and upwards who are employed under a contract of service in manual labour, or in non-manual labour if their remuneration does not exceed £420 a year. The total number of persons in England, Scotland and Wales entitled to benefits on 31st December, 1940, was approximately 22,300,000.

Both employer and employee pay weekly contributions towards health insurance and pensions, and the employer is required to purchase through the post office special stamps of the appropriate value which must be fixed on the employee's contribution card. The employer is entitled to deduct the insured person's share of the cost of the stamps from his wages. The ordinary rate of contribution for employees over age sixteen is 11*d.* a week for men and 10½*d.* a week for women. The employee's share is ordinarily 5½*d.* in the former case and 5*d.* in the latter, but in the case of certain low wage earners the employee's share is less. The contributions cover six-sevenths of the cost of the benefits and their administration in the case of men and four-fifths in the case of women, the balance being provided by the Exchequer. A Parliamentary grant of over £7,000,000 was paid in 1940 towards the cost of the scheme in respect of England, Scotland and Wales. Since 4th April, 1938, all young persons employed between school-leaving age and the age of sixteen are entitled to medical benefit. The contributions payable are 2*d.* each from employer and employed young person. The National Health Insurance (Juvenile Contributors and Young Persons) Act, 1937, which introduced these provisions also requires education authorities to furnish a medical practitioner, on application, for his confidential information, with any particulars from their school medical records regarding any young person accepted by him for treatment.

Benefits. 1. Medical benefit, *i.e.* medical attendance and treatment by a general practitioner, including the supply of medicine, and of such medical and surgical appliances as may be included in a list prescribed by the Minister of Health. (See *B.M.J. Supplement*, 30th October, 1937, p. 275, "The Bottle of Medicine Habit.")

2. Sickness benefit, *i.e.* weekly cash payments during incapacity for work by reason of illness. The ordinary payments are 18*s.* a week for men, 15*s.* for unmarried women, and 13*s.* for married women, beginning on the fourth day of incapacity and continuing for a maximum period for the same illness of twenty-six weeks.

3. Disablement benefit, *i.e.* a continuance of weekly payments after the right to sickness benefit has lapsed (10*s.* 6*d.* for men, 9*s.* for unmarried women, 8*s.* for married women). This benefit is paid until the insured person is fit to return to work or reaches pensionable age.

4. Maternity benefit, *i.e.* payment of £2 on the confinement of an insured woman or the wife of an insured man. If the insured woman is married and is an employed contributor, she receives an additional £2.

5. Additional benefits are paid by approved societies if their accumulated funds are sufficient. Such benefits may take the form of increases in sickness, disablement or maternity benefits or contributions towards the cost of special treatment, such as dental, ophthalmic, hospital or convalescent home. Sanatorium benefit was one of the original benefits, but was excluded from the scheme in 1921 (see p. 83).

The administration of national health insurance is exercised through the Ministry of Health for England, the Department of Health for Scotland and the Welsh Board of Health for Wales. These Central Departments have the power to make regulations on various matters and are the appeal authorities in disputes between insured persons, doctors, chemists, approved societies and insurance committees. Besides the ordinary administrative staff required for the purposes of insurance, the Departments have a considerable number of Insurance Regional Medical Officers whose duty it is to examine insured persons referred to them either by the approved societies or by insurance practitioners, to inspect the records kept by insurance practitioners and to carry out special investigations. During the war the Insurance Regional Medical Service is temporarily suspended in England and Wales, though it still continues to function in Scotland.

Local administration is in the hands of (*a*) approved societies, *i.e.* self-governing associations of insured persons who unite voluntarily to form a society, which must be "approved" by the Central Departments. These societies administer sickness, disablement and maternity benefits, together with any additional benefits they may be in a position to provide. Almost all insured persons belong to one or other of these societies.

(*b*) Insurance committees in every county and county borough administer medical benefit and enter into agreements with local practitioners and chemists. Three-fifths of the

members of an insurance committee are representatives of insured persons elected by approved societies, one-fifth are appointed by the county council or county borough council, two members are medical practitioners appointed by the local medical committee, one is a medical practitioner appointed by the county council or county borough council, and the remaining members are appointed by the Central Departments. The number of members cannot be less than twenty or more than forty, and the number of medical practitioners on the committee cannot be less than three and may be more. Each insurance committee must appoint a medical service sub-committee and a pharmaceutical service sub-committee whose duty it is to investigate complaints against insurance practitioners and persons supplying drugs and appliances and to report to the parent committee. The insurance committee may recommend to the Central Department that a part of a practitioner's remuneration should be withheld from him or that his name should be removed from the medical list. Expenditure incurred by a patient or the committee in consequence of neglect on the part of a practitioner or person supplying drugs and appliances may be recovered from the remuneration of the practitioner or person supplying the drugs and appliances.

(*c*) Local medical committees are constituted by the local medical profession in every county and county borough, and must be consulted by the insurance committee on all general questions affecting the administration of medical benefit. In most areas these committees are the same as—

(*d*) panel committees, appointed by the insurance practitioners of the area. All the members must be doctors, and not fewer than three-fourths must be insurance practitioners.

(*e*) Pharmaceutical committees are elected by the local insurance pharmacists.

The following points in connection with the British system of health insurance should be remembered :—

1. Neither the insurance practitioners nor the insurance chemists have any direct administrative relation to the approved societies.

2. Any registered medical practitioner has the right to require an insurance committee to place his name on the panel of insurance practitioners.

3. An insured person is entitled to choose his own insurance doctor, subject to the doctor's consent, and can change his doctor at any time, if the doctor consents, or without such consent if he gives not less than a month's notice to the insurance committee to terminate at the end of a quarter.

4. An insurance practitioner may not, without the consent of the Central Department, accept more than 2,500 insured persons on his list, but if he employs a permanent assistant

he may accept additional persons up to a maximum of 1,500.

5. A practitioner contracts with the insurance committee to give his patients "all proper and necessary medical services other than those involving the application of special skill and experience of a degree or kind which general practitioners as a class cannot reasonably be expected to possess."

6. An insurance practitioner is paid 9*s*. 9*d*. a year in respect of each insured person on his list. In 1938 there were about 16,000 doctors in insurance practice in England, and they received £7,514,900 in respect of their services. Insurance chemists received £2,308,900 for the supply of drugs and appliances. In the same year the cost of maternity benefit was £1,457,000, dental benefit £1,809,301, ophthalmic benefit £433,209, convalescent home treatment benefit £105,268, and medical and surgical appliances £108,827.

Unemployment insurance was introduced under the National Health Insurance Act, 1911, when its application was limited to workers in certain industries. Later Acts have extended it to practically the same classes as come within the scope of national health insurance. There are certain excepted occupations, such as private domestic service and service under the Crown. Contributions are made in the same manner as in national health insurance, and amount to 10*d*. a week each from employer and employed in the case of men and 9*d*. in the case of women, the Exchequer contributing a similar sum. There are lower rates for young persons. The general rate of unemployment benefit is 30*s*. a week for the married man (plus allowances for children), 20*s*. for the single man and 18*s*. for the single woman. (See "How to Help Cases of Distress," Charity Organisation Society, 1943).

Beveridge Report. An Inter-departmental Committee on Social Insurance and Allied Services was appointed under the chairmanship of Sir William Beveridge in June, 1941, "to undertake, with special reference to the inter-relation of the schemes, a survey of the existing national schemes of social insurance and allied services, including workmen's compensation, and to make recommendations." The plan outlined in Sir William Beveridge's Report (Command Paper 6404, November, 1942), suggests a comprehensive policy of social progress which includes a scheme for securing an income to take the place of earnings when they are interrupted by unemployment, sickness or accident, provision for retirement through age, insurance against the loss of support by the death of another person, and the meeting of exceptional expenditures such as those connected with birth, marriage and death. The proposals depend on three assumptions : (*a*) the payment of children's allowances, (*b*) comprehensive health and rehabilita-

tion services, and (c) the maintenance of employment. At the moment of writing the Government has accepted the principles involved in (a) and (b) and has under consideration measures for dealing with (c).

PERSONS OF UNSOUND MIND

The law relating to the treatment of such persons was altered by the Mental Treatment Act, 1930. This Act introduced :—

1. Reception in institutions of voluntary patients, *i.e.* without certification under the Lunacy Acts.
2. Reception in institutions of temporary patients on the recommendation of two medical practitioners—again without formal certification under the Lunacy Acts.
3. Provision of temporary treatment in any institution, hospital or nursing home as may be approved by the Board of Control.
4. Certain new powers for local authorities, *i.e.* county councils and county borough councils.
   (*a*) The provision of out-patient treatment for mental cases.
   (*b*) The provision of after-care for such persons and the right to contribute to the funds of voluntary associations undertaking after-care.
   (*c*) The power to contribute to the funds of voluntary associations whose object is the prevention and treatment of mental illness.
   (*d*) The power to undertake research and to make contributions towards the expenses of research.

Asylums are now known as "mental hospitals," paupers as "rate-aided persons" and lunatics as "persons of unsound mind."(See also p. 290.)

THE FACTORIES ACT, 1937

(*In operation* 1*st July*, 1938)

The Factories Act is a consolidating and amending measure and replaces the Factory and Workshop Act of 1901 and various later Acts. The old distinctions between a factory and a workshop and between a textile and a non-textile factory are abolished, and the term "workshop" disappears, only one expression "factory" being employed. It should be noted also that in future the "certifying factory surgeon" will be known as the "examining surgeon"—references to his duties and method of appointment will be found in Parts V., VI. and XI. of the Act (pp. 666, 667, 670).

The Act places the responsibility for the enforcement of its provisions almost wholly upon the Home Office. *District councils*, however, are charged with certain duties relating to

outworkers; the employment of persons in unwholesome premises; basement bakehouses; the provision of sanitary conveniences in the case of all factories, and cleanliness, overcrowding, temperature, ventilation and drainage of floors in the case of factories in which mechanical power is not used. It is of interest that 57 of the 160 sections of the Act enable the Secretary of State to make regulations or orders regarding seventy-five different subjects. Such regulations and orders must be laid before Parliament. Certain of the regulations, known as special regulations, do not need parliamentary approval, but must follow the procedure laid down in the second schedule to the Act.

Generally speaking the occupier of a factory is responsible for seeing that the Act is observed, but in certain cases, *e.g.* tenement factories (see p. 669), the owner is responsible for some of the provisions.

A prescribed abstract of the Act containing *inter alia* the address of the factory inspector for the district and the name and address of the examining surgeon must be posted at the principal entrances to a factory.

Definitions. " Factory " means any premises in which, or within the curtilage or precincts of which, any person is employed in manual labour in any process for or incidental to any of the following purposes :—

(*a*) the making of any article or of part of any article; or

(*b*) the altering, repairing, ornamenting, finishing, cleaning, or washing, or the breaking up or demolition of any article ; or

(*c*) the adapting for sale of any article ;

being premises in which, or within the curtilage or precincts of which, the work is carried on by way of trade or for purposes of gain and to or over which the employer of the persons employed therein has the right of access or control.

The Act specifies as factories certain types of premises about which doubt might exist, *e.g.* shipyards and dry docks ; film studios ; premises used for the storage of gas in a gasholder of a storage capacity of not less than 5,000 cubic feet. The Act also extends the definition of " factories " to premises in which certain kinds of work are done as a preliminary to the business carried on in any factory or incidentally to the purposes of any factory, *e.g.* premises used for the sorting of articles, laundries, locomotive shops, private sidings and garages, and letterpress printing works. (See also definition of " workplace " in P.H.A., 1936, p. 544.) Premises

are not excluded from the definition of "factory" by reason only that they are open-air premises.

"District council" means the council of a borough or county district.

"Prime mover" means every engine, motor or other appliance which provides mechanical energy derived from steam, water, wind, electricity, the combustion of fuel or other source.

"Woman" means a woman who has attained the age of eighteen.

"Young person" means a person who has attained the age of fourteen (or other statutory school-leaving age) and has not attained the age of eighteen.

Part I Health (Sects. 1–11)

1. **Cleanliness.** Every factory must be kept in a clean state and free from effluvia arising from any drain, sanitary convenience or nuisance.

Accumulations of dirt and refuse must be removed daily by a suitable method from the floors and benches of workrooms, and from the staircases and passages.

The floor of every workroom must be cleaned at least once a week by washing or, if it is effective and suitable, by sweeping or other method.

All inside walls and ceilings must be (*a*), if they have a smooth impervious surface, washed with hot water and soap every fourteen months or cleaned by such other method as may be approved by the M.O.H. or the district inspector, (*b*), if they are painted or varnished, repainted or revarnished every seven years and washed every fourteen months with hot water and soap or cleaned by such other method as may be approved by the M.O.H. or the district inspector, (*c*), in all other cases, whitewashed every fourteen months. These provisions relating to walls and ceilings do not apply to a factory where mechanical power is not used and less than ten persons are employed unless the M.O.H. or district inspector so directs. The date of washing, whitewashing, painting or varnishing must be entered in the general register which Sect. 116 requires every factory to keep. (The Factories (Cleanliness of Walls and Ceilings) Order, 1938.)

2. **Overcrowding.** A factory must not, while work is carried on, be so overcrowded as to cause risk of injury to the health of the persons employed therein.

A factory is deemed to be "overcrowded" if there is less than 400 cubic feet of space for every person employed in any workroom—no space more than 14 feet above the floor should be taken into account in the calculation.

A space of 250 cubic feet was permitted until 30th July,

1942, in respect of workrooms in use at the date of the passing of this Act, and for a further period of five years if suitable mechanical ventilation has been provided in the room. The M.O.H. or the district inspector may, however, require such ventilation to be provided during the first five years.

A notice must be placed in every workroom specifying the number of persons who may be employed in that room unless the M.O.H. or a district inspector otherwise allows.

The Secretary of State may make regulations increasing the number of cubic feet per person in the case of any class of factory or any particular manufacturing process.

3. **Temperature.** Effective provision must be made for securing and maintaining a reasonable temperature in each workroom.

In every workroom, in which a substantial proportion of the work is done sitting and does not involve serious physical effort, a temperature of less than 60° F. shall not be deemed, after the first hour, to be a reasonable temperature while work is going on, and at least one thermometer must be provided and maintained in a suitable position in every such workroom.

The Secretary of State may make regulations regarding these matters.

4. **Ventilation.** Effective and suitable provision must be made for securing and maintaining by the circulation of fresh air in each workroom the adequate ventilation of the room, and for rendering harmless, so far as practicable, all fumes, dust and other impurities that may be injurious to health generated in the course of the work.

The Secretary of State may make regulations prescribing standards of adequate ventilation.

5. **Lighting.** Effective provision must be made for securing and maintaining sufficient and suitable lighting, whether natural or artificial, in every part of a factory in which persons are working or passing.

The Secretary of State may make regulations prescribing standards of lighting.

All glazed windows and skylights used for the lighting of workrooms must be kept clean.

6. **Drainage of floors.** Where any process is carried on which renders the floor liable to be wet to such an extent that the wet is capable of being removed by drainage, effective means must be provided and maintained for draining off the wet.

7. **Sanitary conveniences.** Sufficient and suitable sanitary conveniences must be provided, maintained and kept clean in every factory. The conveniences must be lighted and must be separate for each sex.

The Secretary of State may make regulations determining what is sufficient and suitable provision.

The Sanitary Accommodation Regulations, 1938, provide for factories as follows :—

(*a*) One closet for every 25 males or females ;

(*b*) when males exceed 100, and sufficient urinal accommodation is provided, one closet for every 25 males up to the first 100, and one for every 40 after that ;

(*c*) if males exceed 500, one closet for every 60 will suffice, provided there is sufficient urinal accommodation and the M.O.H. certifies that the arrangements are satisfactory ;

(*d*) sanitary conveniences must be kept clean, must not communicate directly with workrooms except through the open air or through an intervening ventilated space and must be under cover and partitioned off (with fastening door). Completely separate arrangements must be made for the two sexes.

8. **Enforcement.** *District councils* enforce—

(*a*) in the case of all factories, the provisions as to sanitary conveniences ;

(*b*) in the case of factories in which mechanical power is not used, the provisions as to cleanliness, overcrowding, temperature, ventilation and drainage of floors—but not those as to lighting.

There are two exceptions to (*b*) namely (i.) cases specified by the Secretary of State where there are special provisions in the Act or Regulations against risk of industrial disease or other injury to health, and (ii.) certain railway, dock and canal premises. In such cases the enforcement will rest with the factory inspectors. Crown factories are also outside the jurisdiction of *district councils*.

Every *district council* must keep a register of all factories within their district.

9. The factory inspector must notify the *district council* in writing if he finds any act or default in relation to any drain, sanitary convenience, water supply, nuisance or other matter in a factory which is liable to be dealt with by the *district council*.

The council must inform the factory inspector of any proceedings taken in consequence of the notice.

If within one month after such notice proceedings are not taken by the *district council* for dealing with the matter, the factory inspector himself may take proceedings and may recover expenses from the *district council* summarily as a civil debt.

10. If the Secretary of State is satisfied that any *district council* have failed to enforce any of the provisions of this portion of the Act enforceable by them, he may, by order, authorise a factory inspector to take such steps as appear necessary for enforcing these provisions.

11. **Medical supervision.** The Secretary of State may make special regulations requiring arrangements to be made for the medical supervision (not including medical treatment other than first-aid and medical treatment of a preventive character) of persons employed in any factory where : (*a*) cases of illness have occurred which may be due to the nature of a process or other conditions of work ; or (*b*), by reason of changes in any process or the introduction of any new process, there may be risk of injury to the health of persons employed ; or (*c*) young persons are or are about to be employed in work which may cause risk of injury to their health.

Part II. Safety (Sects. 12–40)

This part of the Act deals with such matters as prevention of accidents, the precautions to be taken with respect to dangerous fumes and inflammable dust, gas or vapour, and means of escape in case of fire.

Every factory in which more than twenty persons are employed, or in which more than ten persons are employed on any floor above the ground floor, must be certified by the *district council* as being provided with reasonable means of escape in case of fire. *District councils* have power to make bylaws as to such means of escape in case of fire and the Minister of Health is the confirming authority.

Part III. Welfare (Sects. 41–46)

1. *Drinking water.* An adequate supply of wholesome drinking water must be provided in factories at suitable and conveniently accessible points. Water must be drawn from a public main or from some other source approved in writing by the *district council.* If the water is not laid on, it must be contained in suitable vessels, renewed at least daily, and both water and vessels must be protected from contamination. Except where the water is delivered in an upward jet, suitable cups must be provided with facilities for rinsing them in drinking water. Where the district inspector so directs the supply must be clearly marked " Drinking Water."

2. *Washing facilities.* Adequate and conveniently accessible washing facilities must be provided, including soap and clean towels or other suitable means of cleaning or drying. Such facilities must be kept in a clean and orderly condition.

The Secretary of State may make regulations regarding these matters and may exempt factories from any of these requirements if the requirement would in his opinion be unreasonable (*e.g.* The Washing Facilities (Dermatitis) Order, 1938).

3. *Accommodation for clothing.* Adequate and suitable accommodation must be provided for clothing not worn during

working hours and, if necessary, arrangements for drying such clothing.

The Secretary of State may make regulations regarding these matters and may in special circumstances exempt certain factories.

4. *Seats.* Seats must be provided for female workers whose work is done standing in order that they may rest whenever possible during the course of their employment.

5. *First aid.* A first-aid box or cupboard of the prescribed standard must be provided, and where more than 150 persons are employed an additional box or cupboard for every additional 150 persons. Any fraction of 150 must be reckoned as 150. Every first-aid box or cupboard must be under the charge of a responsible person who must, in the case of a factory where more than fifty persons are employed, be trained in first-aid treatment. The person in charge must always be readily available during working hours and his name must be affixed in every workroom.

The chief inspector of factories may by certificate exempt a factory from these requirements if an ambulance room is provided and arrangements are made to ensure the immediate treatment of all injuries occurring in the factory. (The First Aid in Factories Order, 1938, specifies the contents of the first-aid boxes or cupboards required.)

6. *Special welfare regulations.* The Secretary of State may make special regulations with regard to any of the foregoing provisions of this part of the Act and, in addition, to arrangements for preparing or heating, or taking meals ; to the supply of protective clothing ; to ambulance and first-aid arrangements ; to the supply and use of seats in workrooms ; to rest rooms ; and to arrangements for the supervision of persons employed.

Such welfare regulations may provide for the employed persons concerned being associated in the management of the arrangements for which provision is made, in any case where a proportion of the cost is contributed by them. No contribution must be required from the persons employed in any factory except for the purpose of providing additional or special benefits which, in the opinion of the Secretary of State, could not reasonably be required to be provided by the employer alone, and unless two-thirds at least of the employed persons affected in that factory give their assent.

Part IV. Health, safety and welfare (Sects. 47–63)

(See also p. 143).

1. *Removal of dust or fumes.* All practicable measures must be taken to protect the persons employed in any factory against inhalation of dust or fume likely to be injurious or

offensive, and to prevent its accumulating in any workroom. Exhaust appliances must be provided, wherever practicable, as near as possible to the point of origin of the dust or fume.

2. *Meals in certain dangerous trades.* Persons must not be permitted to partake of food or drink or to remain during the intervals allowed for meals or rest in any room where lead, arsenic or other poisonous substance is so used as to give rise to any dust or fume. Persons may not remain during the intervals allowed for meals or rest in any room in which a process is carried on which has been prescribed by the Secretary of State as a process giving rise to siliceous or asbestos dust.

Suitable provision must be made elsewhere in the factory to enable all such persons to take their meals.

3. *Protection of the eyes.* Suitable goggles or effective screens must be provided to protect the eyes of the persons employed in any process specified by the Secretary of State to involve a special risk of injury to the eyes from particles or fragments thrown off in the course of the process (*e.g.* Protection of Eyes Regs., 1938).

4. "*Shuttle kissing.*" The Secretary of State may make special regulations for extending the provision and use in factories, in which the weaving of cotton or other cloth is carried on, of shuttles which are not capable of being readily threaded by suction of the mouth.

5. *Use of white phosphorus in manufacture of matches.* No person may use white phosphorus in the manufacture of matches. The importation of matches made with white phosphorus is forbidden.

6. *Humid factories.* In every factory in which humidity is artificially produced two special hygrometers must be provided, one fixed in the centre and one at the side of each room. These hygrometers must be read twice daily between 10 and 11 a.m. and between 3 and 4 p.m., and the readings recorded. No artificial humidification is permitted in any room when the reading of the wet bulb thermometer exceeds 72·5° F. (in certain special processes this figure is fixed at 80° F.). No water may be used for humidification which absorbs from acid solution of permanganate of potash in four hours at 60° more than half a grain of oxygen per gallon of water.

7. *Bakehouses.* No bakehouse must have a sanitary convenience communicating directly with it, nor must any drain carrying sewage have an opening into it. Every cistern supplying water to a bakehouse must be separate and distinct from any cistern supplying water to a water closet. No place on the same level as a bakehouse and forming part of the same building may be used as a sleeping place unless it is separated from the bakehouse by a partition extending from floor to ceiling and has an external glazed window of at least 9 superficial feet

in area of which at least 4½ superficial feet are made to open. (Third Schedule.)

8. *Underground rooms.* An "underground room" means any room which or any part of which is so situated that half or more than half of its height is below the surface of the footway of the adjoining street or of the ground nearest to the room.

No work may be carried on in an underground room certified by the factory inspector for the district to be unsuitable for the purpose as regards construction, height, light or ventilation, or on any other hygienic ground, or on the ground that adequate means of escape in case of fire are not provided.

In the case of any underground room not forming part of a factory at the commencement of this Act, the occupier must, before using the room for work for which it may be certified as unsuitable, give notice to the factory inspector for the district.

An aggrieved occupier has the right of appeal to a court of summary jurisdiction.

9. *Basement bakehouses.* "Basement bakehouse" means a bakehouse any baking room of which is so situated that the surface of the floor is more than 3 feet below the surface of the footway of the adjoining street or of the ground nearest to the room.

A basement bakehouse must not be used as a bakehouse unless it was so used at the date of the passing of this Act and a certificate of suitability has been issued by the *district council.* Any basement bakehouse which is not used as a bakehouse for a period exceeding twelve months must not be so used again.

Every *district council* must, in the year beginning at the date of the commencement of this Act and in every fifth succeeding year, carry out an examination of every basement bakehouse in respect of which a certificate of suitability has been issued. If as a result of this examination the *council* are not satisfied that the bakehouse is suitable for use as such as regards construction, height, light, ventilation and any hygienic respect, they must give notice in writing that the certificate shall cease to have effect after the expiration of such period, being not less than one month, as may be specified in the notice.

The occupier may, within twenty-one days of the notice, appeal to a court of summary jurisdiction.

N.B. An Order of 30.12.03 is still in force which requires 500 cubic feet of space per person in underground bakehouses and 400 cubic feet between 9 p.m. and 6 a.m. in bakehouses not underground where work is done at night by artificial light other than electric.

10. *Laundries.* Effective steps must be taken by means of a fan or otherwise to regulate the temperature in every ironing room, and to carry away the steam in every wash-house.

All stoves for heating irons must be so separated from any ironing room or ironing table as to protect the workers from the heat thereof.

No gas iron emitting any noxious fumes may be used.

11. *Lifting excessive weights.* A young person must not be employed to lift, carry or move any load so heavy as to be likely to cause injury to him.

The Secretary of State may make special regulations prescribing the maximum weights which may be lifted, carried or moved by persons employed in factories.

(See Home Office Safety Pamphlet No. 16, 1937, " Weight Lifting by Industrial Workers ".)

12. *Employment of female young persons in certain processes.* Female young persons may not be employed in certain processes in glass and salt works, and the employment of women and young persons is prohibited in certain processes connected with lead manufacture. (Sects. 57 and 58.)

13. *Employment of women and young persons in processes involving use of lead compounds.* Women and young persons may not be employed in any process involving the use of lead compounds if the process is such that dust or fume from a lead compound is produced therein, or the persons employed therein are liable to be splashed with any lead compound in the course of their employment, unless the following provisions are complied with :—

(*a*) effective exhaust draught near the point of origin of the dust or fume ;

(*b*) periodic medical inspection ;

(*c*) no food, drink or tobacco may be consumed in any room in which the process is carried on, nor may any person remain in such a room during meal times ;

(*d*) suitable protective clothing ;

(*e*) suitable cloakroom, mess-room and washing accommodation ;

(*f*) the workroom, tools and apparatus must be kept in a clean state.

N.B. " Lead compound " means any soluble compound of lead declared by regulations of the Secretary of State to be a lead compound for the purposes of this section.

14. *Special regulations for safety and health.* The Secretary of State may make special regulations for safety and health in respect of any process of such a nature as to cause risk of bodily injury to persons employed in connection therewith.

Part V. Accidents and industrial diseases (Sects. 64–69)

1. All fatal accidents and accidents disabling persons for more than three days must be notified to the factory inspector for the district.

2. Medical practitioners must notify all cases of lead, phosphorus, arsenical or mercurial poisoning, or anthrax, contracted in any factory to "The Chief Inspector of Factories, London." The notice must give the name and address of the factory in which the patient was last employed. The practitioner is entitled to a notification fee of 2*s.* 6*d.* There is a penalty not exceeding 40*s.* for default. The Secretary of State may by regulations require notification of other diseases contracted in factories. (Other diseases already made notifiable are toxic jaundice, epitheliomatous ulceration and chrome ulceration, compressed air illness, toxic anæmia, poisoning from carbon bisulphide, aniline, benzene (chronic) and manganese.)

The occupier of a factory in which any such case has occurred must notify the fact to the factory inspector for the district and to the examining surgeon.

A factory inspector or some person on behalf of the Secretary of State must be present when a coroner holds an inquest on the body of any person whose death may have been caused by any accident or disease of which notification is required to be given by this Act.

The Secretary of State may direct a formal investigation to be held into any accident occurring or case of disease contracted or suspected to have been contracted in a factory.

It is the duty of the examining surgeon to investigate and report upon :

(*a*) cases of death or injury caused by exposure in a factory to fumes or other noxious substances, or due to any other special cause specified by the Secretary of State ; and

(*b*) any case of death or injury which the factory inspector for the district may refer to him for that purpose ; and

(*c*) any case of disease of which he received notice under this Act.

Part VI. Employment of women and young persons (Sects. 70–100)

The general conditions as to hours of employment and holidays of these persons are defined. There are two sets of provisions as to hours—one for ordinary factory workers of these protected classes and the other applicable to some classes of young persons whose hours have not previously been regulated, *e.g.* certain van boys and errand boys employed wholly or mainly outside the factory. Both sets of hours are based on a forty-eight hour week, with a forty-four hour week after June, 1939, for those under sixteen, and with certain amounts of overtime for women and for young persons aged sixteen or over. (Night Work of Male Young Persons (Medical Examinations) Regs., 1938.) Where a young person is employed

on any day in a factory and is subsequently on the same day employed about the business of a shop, the working hours for that day in both employments together must not exceed the daily maximum permitted by the Factories Act. (Young Persons (Employment) Act, 1938.)

Certificate of fitness of young persons. A young person under the age of sixteen years must not remain in employment in a factory after the expiration of a prescribed period (fourteen days) unless he has obtained a certificate of fitness from the examining surgeon. The examining surgeon may, if he thinks fit, issue a provisional certificate authorising the employment of the young person for a period not exceeding twenty-one days.

Any certificate by the examining surgeon may be issued subject to conditions as respects the nature of the work in which the person concerned is to be employed and, if necessary, subject to a condition that he shall be re-examined after an interval specified in the certificate. The examining surgeon may extend the application of the conditions beyond the age of sixteen (but not beyond eighteen).

If a certificate is refused or revoked, the examining surgeon must on request give to the parents in writing the reasons for the refusal or revocation.

The Secretary of State may make rules prescribing the manner in which, and the place at which, examinations may be conducted and the facilities to be afforded by the occupiers of factories for the examinations, including facilities for the examining surgeon to inspect any process in which a young person is to be employed. (The Young Persons (Certificates of Fitness) Rules, 1938.)

Every *local education authority* must arrange for their officers to furnish, on the application of the examining surgeon for his confidential information, particulars of the school medical record and other information in their possession regarding the medical history of a young person. The Minister of Health may make rules, or arrange that the Board of Education may make such rules on his behalf, for this purpose.

The Secretary of State may by regulations exempt from the application of these provisions regarding certificates of fitness for employment of young persons any class of factory in which mechanical power is not used.

The factory inspector may require the occupier of a factory to obtain from the examining surgeon a certificate of fitness for work in the case of any young person engaged on work in a factory which appears to be prejudicial to health.

Part VII. Special applications and extensions (Sects. 101–109)

1. *Premises in respect of which owner is liable.* Sections 101 and 102 deal with (*a*) tenement factories and (*b*) other buildings of

which a part is let off as a separate factory, *e.g.* where one or more floors of a building are let off as a factory or factories and the other floors are used as shops or offices.

(*a*) A tenement factory means premises at least two parts of which are occupied by different persons as separate factories and supplied with mechanical power for use in manufacturing processes from a prime mover within the premises. The parts occupied as separate factories are called "tenements" and the whole premises are the tenement factory. A common class of case is where the owner of the tenement factory runs an engine in the basement which supplies motive power to the machines in various tenements let off to small employers or to groups of persons working on their own account.

Broadly speaking, the owner is responsible for structural requirements and for the provision and maintenance of safety appliances for machinery or plant not belonging to or supplied by tenement occupiers. He is also responsible for the notices fixing hours of employment and for the notification of accidents except in the case of a room occupied by not more than one tenant. As regards those parts of the tenement factory not let off as separate tenements, he is responsible for the provisions of the Act generally.

(*b*) In the second class of premises the owner is responsible for cleanliness and lighting, prime movers and transmission machinery, hoists and lifts, steam boilers and the construction and maintenance of floors, passages and stairs as regards parts of the building used for the purposes of the factory but not comprised therein. As regards those parts of the premises used as a factory, the owner is responsible for the provision of sanitary conveniences—but not for their cleanliness unless used in common by several tenants—and for certain matters relating to hoists and lifts, steam boilers and means of escape in case of fire—but only in so far as these matters are within the owner's control.

2. "*Building operations*" and "*works of engineering construction*" (Sects. 107 and 108). "Building operations" means the construction, alteration, repair, maintenance and demolition of a building. "Works of engineering construction" includes the construction, alteration, repair or demolition of any dock, tunnel, bridge, viaduct, waterworks, reservoir, pipe-line, aqueduct, sewer, sewage works or gasholder. The provisions of this Act applicable to the above operations and works include:

(i.) notification and investigation of accidents;
(ii.) regulations for safety, health and welfare;
(iii.) sanitary conveniences.

Any person undertaking such work must notify the district factory inspector.

Part VIII. Home work (Sects. 110 and 111)

1. (*Sect.* 110). In the case of persons employed in such classes of work as may be specified by the Secretary of State, the occupier of every factory and every contractor employed by him must keep lists showing the names and addresses of all outworkers directly employed by him and of the places where they are employed, and must send to the district council in February and in August in each year copies of those lists showing all outworkers so employed by him during the preceding six months.

Every *district council* must forward the name and place of employment of every outworker included in any such list to the council in whose district the place of employment of the outworker is situated.

2. (*Sect.* 111). A *district council* may, by notice in writing to the occupier of a factory or to any contractor employed by him, prohibit the employment of any persons as home workers in premises which the council regard as injurious or dangerous to health. Particulars of the respects in which the premises are injurious or dangerous must be stated in the notice and, if the occupier of the factory or his contractor gives out work to be done in those premises after the expiration of ten days from the receipt of the notice, he is liable to proceedings. This section applies only to such classes of work as may be specified by the Secretary of State.

N.B. The Home Work Order, 1911, specifies the kinds of work to which these two sections apply. The work is connected mainly with wearing apparel and various textiles, the making of paper bags, boxes, brushes, baskets, artificial flowers, metal fittings, etc. (See also P.H.A., 1936, p. 552, regarding home work in premises where notifiable disease exists.)

Part XI. Administration (Sects. 122–129)

1. *Factory inspectors.* Factory inspectors are appointed by the Secretary of State and have power to enter and inspect factories at all reasonable times by day or night.

A factory inspector who is a duly qualified medical practitioner has authority to carry out such medical examinations as may be necessary for the purpose of his duties under this Act.

An inspector, if so authorised in writing by the Secretary of State, may conduct or defend before a court of summary jurisdiction any proceeding arising under this Act.

2. *Examining surgeons* (see also pp. 667 and 668). The chief inspector or a superintending inspector for a division

may appoint a sufficient number of qualified medical practitioners to be examining surgeons and may revoke any such appointment.

A medical practitioner who is directly or indirectly interested in any process or business carried on in a factory may not act as examining surgeon for that factory; provided that the Secretary of State may authorise a medical practitioner who is employed by the occupier of the factory in connection with the medical supervision of persons employed in the factory, but is not otherwise interested in the factory, to act as examining surgeon for that factory for the purpose of examining and certifying the fitness of young persons.

An examining surgeon must, if so directed by the Secretary of State, make such special inquiry and examination of employed persons as may be directed, and must every year report to the Secretary of State as to examinations made and other duties performed by him.

If and so long as there is no examining surgeon for a factory, the poor law medical officer for the district must act as examining surgeon.

The fees (approximately 2*s.* 6*d.* per person) to be paid to examining surgeons for examinations and certificates are payable by the occupier of the factory. (Fees of Examining Surgeons Order, 1938.)

(Under the Workmen's Compensation Act (see p. 146) the examining surgeon has the duty of examining any workman, on payment by the workman of the prescribed fee, and of certifying either that he is or is not disabled by any of the scheduled diseases. There is an appeal against his decision to a medical referee.)

3. **County and district councils.** The M.O.H. of every *district council* must include in his annual report particulars relating to the administration of Part I. and Part VIII. of this Act in so far as the duties of the district council are concerned and must send a copy of his annual report to the Secretary of State. He must also give written notice to the district factory inspector of any factory coming to his knowledge in which an abstract of the Act has not been affixed.

A county council and a district council and their officers have, in relation to their duties under this Act, all the powers of a factory inspector. Only officers of the council, so authorised in writing, have powers of entry and inspection. Any such person admitted to a factory, who discloses (save in the performance of his duty) any information obtained by him in the factory with regard to any manufacturing process or trade secret, is liable to a fine not exceeding £100 or to imprisonment for three months.

(See Home Office "A Guide to the Factories Act, 1937,"

and "Memorandum as to Duties of Local Authorities under the Factories Act, 1937.")

THE LAW RELATING TO SHOPS

The Shops Act, 1912. "Shop" includes any premises where any retail trade or business is carried on. Such businesses include the business of a hairdresser, the sale of refreshments and retail sales by auction.

"Local authority" means the common council of the City of London, a borough council, an urban district council (if population of district 20,000 or over), elsewhere a county council.

1. Shop-assistants must have three-quarters of an hour for dinner if taken on the premises, and one hour if taken out. Half an hour for tea must be allowed.

2. Every shop-assistant must have a weekly half-holiday. Notice of these provisions must be displayed in the shop.

3. Seats must be provided for female shop-assistants in the proportion of at least one seat to every three assistants. The Shops Act, 1934, requires shop-owners to permit the assistants to use such seats when it does not interfere with their work.

4. Orders may be made fixing a particular day for half-day closing and fixing the closing hours at night. Certain classes of shops—*e.g.* those for the sale of medicines and surgical appliances—are not required to close for a half-day a week.

Shops (Hours of Closing) Act, 1928. Shops must be closed at 8 p.m. every weekday except on Saturday, when the hour is 9 p.m. The local authority may by order fix some other day as the late day. Confectionery, ice-cream and tobacco shops may remain open till 10 p.m. on the late day and 9.30 p.m. on other days, but these hours may all be varied by order of the local authority, provided a majority of the shop-keepers so desire.

Shops Act, 1934. This Act is mainly concerned with the hours of employment of young persons under the age of eighteen years. "Shop" includes wholesale shops and warehouses.

(1) No young person shall be employed about the business of a shop for more than forty-eight hours in any week.

(2) At periods of exceptional pressure young persons over sixteen years may be employed overtime, provided that no such period may last more than six weeks in any year and that no young person shall work more than fifty hours overtime in a year, or more than twelve hours overtime in a week.

(3) Every young person shall in every period of twenty-four hours be allowed an interval of eleven consecutive hours, including the hours 10 p.m. to 6 a.m.—excepting between 5 a.m. and 6 a.m. in the case of boys delivering milk, bread or newspapers.

(4) The occupier of a shop must keep records of the time worked by his young persons.

Special provisions are included in respect of the catering trade; the trade of selling accessories for aircraft, motor cars and cycles; and theatres.

(The Young Persons (Employment) Act, 1938, amended the Shops Act, 1934, and fixed the maximum working hours for young persons under sixteen at forty-four per week except during the Christmas season when the hours may be averaged over a fortnight. During this period no young person under sixteen may work more than forty-eight hours in either week nor more than eighty-eight hours in the fortnight.)

Shop workers generally;—

(1) In every part of a shop in which persons are employed about the business of the shop—

(*a*) suitable and sufficient means of ventilation shall be provided and suitable and sufficient ventilation shall be maintained;

(*b*) suitable and sufficient means shall be provided to maintain a reasonable temperature and a reasonable temperature shall be maintained;

(*c*) suitable and sufficient means of lighting shall be provided and every such part of a shop shall be kept suitably and sufficiently lighted.

(2) Where people employed about the business of a shop take any meals in the shop, there shall be provided and maintained suitable and sufficient facilities for the taking of those meals.

(3) Unless special exemption is granted by the L.A., in every shop there shall be provided and maintained suitable and sufficient sanitary conveniences and washing facilities available for the use of persons employed in or about the shop.

It is the duty of the local health authority to enforce the provisions relating to ventilation and temperature of shops and to sanitary conveniences, and of the L.A. under the Shops Act, 1912, those relating to lighting and the facilities for washing and taking meals. See Home Office Memoranda on Part I of the Young Persons (Employment) Act, 1938, and on the Shops Act, 1934 (as amended by Part II of the Young Persons (Employment) Act, 1938); see also the Shops Regulations, 1939.

RAG FLOCK ACTS, 1911 and 1928

No person may sell or use rag flock for making upholstery, bedding, etc., unless the flock conforms with the following regulations made by the Min. of H. in 1912:—When not less than 40 grammes of flock are thoroughly washed with distilled water at a temperature not exceeding 25° C., the chlorine must not exceed 30 parts per 100,000 of flock. This standard ensures a certain degree of cleanliness.

"Rag flock" means flock made wholly or partly by tearing up woven or knitted or felted materials, whether old or new, but does not include flock obtained wholly in the processes of the scouring and finishing of newly woven or newly knitted or newly felted fabrics.

RATS AND MICE DESTRUCTION

Under the **Rats and Mice (Destruction) Act, 1919**, every occupier of land or buildings is required to take such steps as may from time to time be necessary and reasonably practicable for the destruction of rats and mice on or in any lands or buildings of which he is the occupier, or for preventing such land and buildings from becoming infested with rats or mice. In default, penalty not exceeding £5.

Any occupier who has been served with a notice under this Act, and who fails to take such steps as are prescribed in the notice, is liable to a fine not exceeding £20.

County councils, county borough councils and port health authorities are the authorities for enforcing this Act. In default the Min. of Ag. and Fish. may order some other person to act. The Act applies to vessels, and the master is deemed to be the occupier.

For the more effective control of rats in war-time various Orders have been made under the Defence (General) Regulations, 1939. The Rats Order, 1940, enables County War Agricultural Executive Committees to serve on occupiers orders requiring the destruction of rats and, if necessary, to prosecute for failure to comply with such orders. In default the committees may have the necessary work carried out and charge the cost to the defaulter. The Food Control Committees (Destruction of Rats and Mice) Order, 1940, enables Food Control Committees to give such directions in respect of any public utility or trade undertaking as may be expedient for the prevention of damage to food by rats or mice, and, if necessary, to prosecute for failure to comply with a direction. The Rats Orders, 1941, and 1942, require that, before threshing, all ricks of corn, rye, beans, peas, linseed or clover must be surrounded by a fence impenetrable to rats, not less than 30 inches high and not less than 6 feet away from the base of the rick (not less than 3 feet on the side on which the threshing tackle is placed). These Orders also require the destruction of rats escaping from the rick during the operation of threshing.

Power of entry

The M.O.H. has right of entry to various premises and for various purposes as follows :—

Basement bakehouses—Factories Act, 1937, s. 128.
Canal boats—P.H.A., 1936, s. 255.

Common lodging houses—P.H.A., 1936, s. 241 (4).

Factories—the Factories Act, 1937, s. 128.

Food and drugs—Food and Drugs Act, 1938, s. 77 ; P.H. (Preservatives, etc., in Food) Regs., 1927, Art. 6.

Housing Acts purposes (general)—Housing Act, 1936, s. 157 (on giving twenty-four hours' notice to the occupier and to the owner, if he is known).

Infectious disease regulations—P.H.A., 1936, s. 143 (4).

Nursing homes—P.H.A., 1936, s. 191.

Public Health Act, 1936—for general purposes of the Act—s. 287.

Rats and mice—Rats and Mice (Destruction) Act, 1919, s. 5.

Ships—Port Sanitary Regulations, 1933, Art. 29.

Shops—Shops Acts, 1912, s. 13, and 1934, s. 13.

Slaughtering of animals—Slaughter of Animals Act, 1933, s. 7.

Trade effluent sampling—P.H. (Drainage of Trade Premises) Act, 1937, s. 10.

APPENDIX I

ATMOSPHERIC MOISTURE, MEASUREMENT OF HUMIDITY, VAPOUR PRESSURE TABLES

Atmospheric moisture. Air has a definite capacity for absorbing moisture, the amount being governed by its temperature. The quantity necessary to cause complete saturation is specific for each degree. For example, at 32° F. the pressure due to the moisture of the air when saturated is equal to about $\frac{1}{160}$ of an atmosphere. When that moisture pressure is reached at that temperature further evaporation or absorption is impossible.

When an atmosphere is saturated with moisture its " relative humidity " is 100 per cent. **Relative humidity** may be defined as the percentage amount of moisture in the air, regarding saturation as 100. **Absolute humidity** is the actual weight of moisture present in a cubic foot of air. The **dew-point** is the temperature at which the air becomes saturated with moisture. A cubic foot of air at 32° F. is absolutely saturated when it contains 2·13 grains of water vapour. Its relative humidity therefore is 100 per cent., its absolute humidity 2·13 grains, and its dew-point 32° F.

If the temperature of air is raised, its power of absorbing moisture is increased. In other words, its relative humidity is reduced but its absolute humidity remains the same. If the temperature of the air in the above example were raised to that degree at which 4·26 grains of moisture would have to be present per cubic foot of air in order to cause saturation, its relative humidity would drop to 50 per cent., as it now contains only half the amount of moisture it could contain. From this it must follow that an atmosphere feels moist, not so much on account of the amount of moisture it holds, but because its temperature is such that the air is near its saturation point. Therefore the greater the difference between the temperature of the air and its dew-point, the lower the relative humidity, and the greater its drying power. The percentage **drying power,** then, is the difference between 100 and the relative humidity.

As night approaches the temperature of the air falls and its saturation point is gradually reached. If the drop in the temperature is sufficiently great, the air arrives at a super-saturated condition and dew is deposited. If the temperature of this super-saturated condition is below 32° F., the vapour of the air must have been subjected to a freezing temperature and therefore frozen vapour or frost is formed.

It is believed that the condensation of moisture takes place

on solid particles which float in the air and act as a nucleus for the moisture. This condition in a quiescent atmosphere causes a mist or fog ; the difference between the two is entirely one of degree as measured by visibility. If the moisture is in excess, a wet fog results. In large manufacturing towns the solid carbon particles which have been discharged into the atmosphere act as nuclei and cause the characteristic black fog. The pungency which usually accompanies this type of fog is due to the sulphur acids present in the products of imperfectly burnt fuel.

Measurement of humidity. *Hygrometers.* Of these instruments there are two kinds, direct and indirect. Both determine the dew-point, the former by noting the temperature at which the dew is actually deposited, and the latter by means of a formula. Daniell's and Dine's hygrometers are examples of the direct type, and Mason's hygrometer, consisting of wet- and dry-bulb thermometers, is the only one classed as indirect.

Mason's hygrometer is the one in common use. It consists of two mercurial thermometers, the bulb of one being surrounded by strands of cotton, the free ends of which are immersed in a vessel containing water. By capillary attraction the bulb of this thermometer is kept wet. Owing to the chilling effect of the evaporation of the water, the reading of the wet-bulb thermometer is almost invariably lower than that of the dry-bulb. The greater the difference between the two temperatures the drier the air, and conversely the more closely they approximate the wetter the air.

The dew-point may be calculated with the aid of hygrometric tables for the computation of relative humidity, vapour pressure and dew-point from readings of dry- and wet-bulb thermometers; tables are shown on p. 678. Here the vapour pressure is given in millibars at various temperatures (1,000 millibars = 750 millimetres = 29·53 inches, see p. 685). To find the dew-point, take the wet- and dry-bulb readings and make use of the following formula :—

Vapour pressure at dew-point = vapour pressure at wet-bulb temperature $- \dfrac{DB - WB}{2}$ where DB = dry-bulb temperature and WB = wet-bulb temperature.

Example. Say DB = 74° F. and WB = 70° F., then by reference to the tables it will be found that vapour pressure at WB = 25·1 millibars, so that we get $25{\cdot}1 - \dfrac{74 - 70}{} = 25{\cdot}1 - 2 = 23{\cdot}1$. If the tables are again consulted it will be found that a vapour pressure of 23·1 millibars (about) corresponds to a temperature of 68° F., which is the dew-point.

To find the relative humidity the following formula is used—

$$RH = \frac{VP \text{ (at dew-point)} \times 100}{VP \text{ at DBT}}.$$

Now, as the vapour pressure at dew-point is 23·1, by referring to the tables the vapour pressure at 74° F. (which is the DBT) is found to be 28·7 millibars ; then

$$RH = \frac{23{\cdot}1 \times 100}{28{\cdot}7} \quad \frac{2310}{28{\cdot}7} = 80 \text{ per cent. (about).}$$

The above is an empirical formula accurate enough for ordinary purposes but liable to some error at large wet-bulb depressions.

Vapour Pressure Tables (at Saturation)

Temperature Fahrenheit.	Vapour Pressure in Millibars	Temperature Fahrenheit.	Vapour Pressure in Millibars.	Temperature Fahrenheit.	Vapour Pressure in Millibars.
30	5·6	53	13·7	76	30·7
31	5·8	54	14·2	77	31·7
32	6·1	55	14·8	78	32·8
33	6·4	56	15·3	79	33·9
34	6·6	57	15·9	80	35·0
35	6·9	58	16·5	81	36·1
36	7·2	59	17·1	82	37·3
37	7·5	60	17·7	83	38·6
38	7·8	61	18·3	84	39·8
39	8·1	62	19·0	85	41·1
40	8·4	64	20·4	86	42·4
41	8·7	65	21·1	87	43·8
42	9·1	66	21·8	88	45·2
43	9·4	67	22·6	89	46·7
44	9·8	68	23·1	90	48·2
45	10·2	69	24·2	92	51·3
46	10·6	70	25·1	94	54·6
47	11·0	71	25·9	96	58·0
48	11·4	72	26·8	98	61·7
49	11·8	73	27·7	100	65·5
50	12·3	74	28·7	105	76·0
51	12·8	75	29·7	110	88·0
52	13·2				

NOTE. The relative humidity, vapour pressure and dew-point at various readings of the dry- and wet-bulb thermometer can be obtained from hygrometric tables prepared by the Meteorological Office.

Assmann psychrometer. Mason's hygrometer is open to the objection that the reading of the wet bulb is affected by varia-

tions of wind. For greater accuracy the Assmann psychrometer may be used. In this instrument air is drawn over the wet and dry bulbs by a clockwork fan at a speed sufficiently great to nullify any effects due to accidental winds—it has been found that, after a speed of some five miles per hour is reached, further increases of air speed do not affect the reading of the wet bulb. "Sling" or "whirling" psychrometers, where the thermometers are caused to whirl rapidly through the air, may also be used. Special charts or tables should be employed with all these instruments, the Meteorological Office tables issued for use with Mason's hygrometer not being suitable.

APPENDIX II

PHYSICS, CALCULATIONS AND TABLES OF FACTORS WEIGHTS AND MEASURES

Conduction is the transference of heat from particle to particle with no change in their relative positions. Solids get hot by conduction.

Convection is the transference of heat by moving particles. Liquids and gases are heated by convection. The heated, and therefore lighter, particles ascend. The colder ones descend and in their turn get heated.

Radiation is the transmission of heat by means of waves which warm the articles they strike but not the medium through which they pass.

Cohesion is the attraction which molecules have for each other in the same body.

Adhesion is the attraction which they have for each other in different substances.

Charles' Law. Gases expand or contract $\frac{1}{273}$ of their volume for each degree rise or fall from 0° Centigrade, the pressure remaining constant. That is, the coefficient of expansion is $\frac{1}{273}$ of its volume at 0° C., or $\frac{1}{491}$ for each degree Fahrenheit from 32°.

Let it be required to find what 1000 volumes at 10° C. will become at 30° C.

We must first of all find what the 1000 volumes will become at 0° C.

$$1 \text{ volume at } 0°\text{ C. becomes } 1 + \frac{10}{273} \text{ volumes at } 10°\text{ C.}$$

$$\therefore 1000 \text{ volumes at } 0°\text{ C. become } 1000 \times \left(1 + \frac{10}{273}\right) \text{ at } 10°\text{ C.}$$

or $$1000 \text{ volumes at } 10°\text{ C. become } \frac{1000}{1 + \frac{10}{273}} \text{ at } 0°\text{ C.}$$

$$= 964 \text{ (nearly).}$$

$$\therefore \quad 1000 \text{ volumes at } 10°\text{ C. become } 964 \text{ at } 0°\text{ C.}$$

$$\text{Now } 1 \text{ volume at } 0°\text{ C. becomes } 1 + \frac{30}{273} \text{ volumes at } 30°\text{ C.}$$

$$\therefore 964 \text{ volumes at } 0°\text{ C. become } 964 \times \left(1 + \frac{30}{273}\right) \text{ at } 30°\text{ C.}$$

$$= 1070 \text{ (nearly).}$$

$$\therefore 1000 \text{ volumes at } 10°\text{ C. become } 1070 \text{ volumes at } 30°\text{ C.}$$

From this it is obvious that 1 volume at 0° C. becomes $1 - \frac{1}{273}$ at $-1°$ C., and, therefore, if a temperature of $-273°$ C. was reached the gas would have shrunk to nothing. As a matter of fact, the gas would cease to be a gas before such a temperature was reached. For this reason $-273°$ C. is called the absolute zero, and any degree above that, the absolute temperature. Consequently 0° C. becomes 273° absolute. Therefore Charles' Law might have been stated: The volume of a gas varies directly as the absolute temperature. This will simplify the example given above very considerably.

The temperatures given were 10° C. and 30° C.; their absolute temperatures are 283° and 303° respectively. Therefore the 1000 volumes must increase by the same ratio as 303° is to 283°.

i.e. $$\frac{1000 \times 303}{283} = 1070 \text{ (nearly).}$$

The same answer as before.

$$\therefore \qquad v_2 = \frac{v_1 \times (273 + t_2)}{273 + t_1}$$

or $$\frac{v_2}{273 + t_2} = \frac{v_1}{273 + t_1}$$

v_2 = required volume
v_1 = given volume
t_2 = required temperature
t_1 = given temperature

Boyle's Law. The volume of any gas varies inversely as the pressure, the temperature being constant. That is, if the pressure is doubled, the volume is halved.

$\therefore$ 1000 volumes at 740 mm. of mercury pressure become at 760 mm.

$$\frac{1000 \times 740}{760} = 873 \text{ (nearly).}$$

$$\frac{p_1}{\quad} = v_2 \text{ or } v_1p_1 : v_2p_2$$

where p_1 = given pressure.
p_2 = required pressure.

Charles' and Boyle's Laws may then be combined and thus formulated :—

$$\frac{v_1p_1}{273 + t_1} = \frac{v_2p_2}{273 + t_2}.$$

Graham's Law. The rate at which a gas diffuses is inversely proportional to the square root of its relative density. The relative density of an element is its atomic weight, and that of a compound, half its molecular weight. The relative densities of oxygen and hydrogen are 16 and 1 respectively; the rates at which they diffuse therefore are in the ratio of $\frac{1}{\sqrt{16}} : \frac{1}{\sqrt{1}}$. That is, oxygen diffuses four times more slowly than hydrogen.

Inasmuch as the density of hydrogen is 1, and 1 litre weighs 0·08958 gram, the weight of a litre of any gas can be found, if its relative density is known.

The relative density of carbon dioxide is 22. Therefore 1 litre of CO_2 weighs $22 \times 0·08958$ grams. This may be stated in another way. From the above it can be calculated that 11·2 litres of hydrogen weigh 1 gram, and therefore 11·2 litres of CO_2 must weigh 22 grams, and 11·2 litres of oxygen 16 grams. Therefore 11·2 litres of any gas weigh in grams its relative density. To continue the

example, 11·2 litres of dry air weigh 14·47 grams, and the same volume of aqueous vapour $\frac{18}{2}$ grams. From this it must follow that dry air weighs more than a mixture of air and moisture. As the pressure is directly proportional to the weight, moist air is not capable of supporting the same column of mercury as dry air, other things being equal, and therefore the barometer falls when rain is imminent.

Specific heat is the amount of heat required to raise 1 gram of any substance through 1° C., as compared with the amount required to raise 1 gram of water 1° C. Hence it is a relative expression, taking water as the standard. It may be determined by a method of mixtures.

Three grams of mercury at 100° C. are mixed with 1 gram of water at 0° C. The resulting temperature is 9° C. What is the specific heat of mercury?

It is obvious that the heat gained by the water is lost by the mercury.

∴ 3 grams of mercury lost 100° − 9° = 91° C. in raising 1 gram of water through 9° C.

$\therefore 3 \times 91 = 1 \times 9.$

But as each has a specific heat value, each side of the equation must be multiplied by that value.

∴ 3 × 91 × specific heat of mercury = 1 × 9 × specific heat of water.

The specific heat of water is taken as 1.

$$\therefore \quad 273 \times \text{specific heat of mercury} = 9.$$

$$\therefore \quad \frac{9}{273} = \frac{1}{30} = \text{specific heat of mercury.}$$

Now 9 = weight of water (1 gram) × (resulting temperature − the original temperature of the water).

And 273 = weight of mercury (3 grams) × (original temperature of mercury − resulting temperature).

If
W = weight of water.
T = the temperature of the water
w = weight of the substance
t = the temperature of the substance
R.T. = resulting temperature

$$\text{Specific heat} = \frac{W \times (R.T. - T)}{w \times (t - R.T.)}.$$

If an exact determination is required the specific heat of the vessel which contains the water must be taken into account.

The amount of heat a body contains is the product of its mass, temperature, and specific heat. Therefore, if we know the weight of ice melted by a body of known weight and temperature, its specific heat can be calculated from the following equation—

$$M.T.S. = 80\ W.$$

M = weight of the body
T = temperature of the body
S = specific heat ,, ,,
80 = latent heat of water
W = weight of ice melted

$$\therefore \quad \text{specific heat} = \frac{80W}{M.T.}$$

Latent heat is the amount of heat given out or absorbed by a body in the act of changing its state.

If 1 lb. of water at 100° C. be mixed with 1 lb. at 0° C., the resulting temperature will be 50° C. But if 1 lb. of water at 100° C. is mixed with 1 lb. of ice at 0° C., the resulting temperature will be 10° C. This

implies that the water lost 90° C. in melting the ice and in raising its temperature 10° C. The actual amount of heat therefore required just to melt the ice is the amount of heat lost by 1 lb. of water in cooling from 80° C. to 0° C.

The latent heat of steam is determined by a calorimeter. Into a known weight of water at a known temperature steam is made to pass. The steam in condensing will raise the temperature of the water and increase its weight. If these data are known the latent heat of the steam can be calculated. Supposing the weight and temperature of water at the commencement of the experiment are 9 oz. and 15° C., and at the end 10 oz. and 77° C., then 1 oz. of steam has raised 9 oz. of water from 15° C. to 77° C.

$\therefore$ 1 oz. of steam lost 23° C. (100–77) in raising 9 oz. of water 62° C. (77–15).

$\therefore$ 23 + latent heat of steam $= 9 \times 62 = 558$.

$\therefore$ latent heat $= 558 - 23 = 535$.

This is approximately the latent heat of steam. The accurate figure is 537·2.

If ice is melted, and the resultant water is converted to steam, the following phenomena take place: Eighty units of heat are first absorbed in converting the ice to water at 0° C. The water decreases in volume as the temperature rises, until 4° C. is reached, when the water is at its point of maximum density (hence ice floats). Then it expands as the temperature is further raised to 100° C., when it absorbs 537·2 in becoming steam.

Steam is said to be saturated when its temperature is no higher than the water from which it was evolved, or when its temperature corresponds to its generation pressure. Water boils at a temperature in accordance with the pressure. (The pressure may be raised by confining the water being boiled in a vessel with no free outlet for the steam.) The temperature of steam therefore may be raised by raising the boiling-point of the water, this being accomplished by increasing the pressure. Since the steam thus generated satisfies the definitions given above, it is saturated steam. But let the steam as steam be raised in temperature, then its temperature will not only be higher than that of the water, but will also correspond to a greater pressure than that at which it was actually produced. Such steam would be called superheated.

Specific gravity is the ratio of the weight of a volume of any substance to the weight of the same volume of a standard substance, the temperature and pressure being constant. It is a number, therefore—not a weight. The specific gravity of a liquid may be taken by means of a specific gravity bottle, water at 4° C. being the standard.

As far as solids are concerned, these may be placed into four groups.

A. Those heavier than water.
B. Those with the same weight as water.
C. Those lighter than water.
D. Those soluble in water—sugar, for example.

A. The substance is first weighed in air, and secondly when suspended in water.

$$\text{Specific gravity} = \frac{\text{Weight in air}}{\text{Weight lost in water}}$$

This must be so, as the volume of the water displaced equals the volume of the substance immersed, and the weight of water displaced is equal to the weight lost by the substance.

B. The specific gravity of these bodies must be one.

C. A solid lighter than water floats. Its specific gravity is the fraction of itself immersed. This fraction may be calculated by means of a glass cylinder provided with a spout. The cylinder is filled with water until some flows out of the spout. Then the solid is lowered gently into the water, the amount overflowing being caught in a vessel and measured. Suppose 15 c.c. are collected. The solid is now pushed down until the whole of it is submerged, the amount of water displaced again being measured. Let the total amount be 20 c.c. Then $\frac{15}{20}$ of its volume were in the first instance below the surface of the water. Therefore its specific gravity is 0·75.

D. The substance is weighed in air, and then in a liquid which will not dissolve it. Its specific gravity is equal to its weight in air multiplied by the specific gravity of the liquid in which it was weighed and divided by the weight it lost in that liquid.

The expansion of solids and liquids. As in the case of gases, solids and liquids have a coefficient of expansion. If a solid whose length is 1 be raised in temperature from 0 – 1° C., its new length is 1 + its coefficient of expansion. If the temperature is increased to 50° C. the length becomes 1 + (50 × the coefficient); therefore the length of a rod at 50° C. equals its length at 0° C. × {1 + (50 × Coef.)}

For example, say the length at 0° was 3 inches and at 50° C. was 3·000568 inches, then 3·000568 = 3 × {1 + (50 × Coef.)}

$$\frac{3{\cdot}000568}{3} \quad 1 + (50 \times \text{Coef.})$$

that is
$$1{\cdot}0001893 = 1 + (50 \times \text{Coef.})$$
$$1{\cdot}0001893 - 1 = 50 \times \text{Coef.}$$
or
$$\frac{0{\cdot}0001893}{50} = \text{Coef.} = 0{\cdot}00000378.$$

This represents its coefficient of linear expansion. If this reasoning be continued and applied to a square, it is obvious that, if the coefficient be called x, the area of a square at 1° C. will be $(1 + x) \times (1 + x)$, whose area was 1 × 1 at 0° C.

$$(1 + x)^2 = 1 + 2x + x^2.$$

As x^2 is a negligible quantity, the square expansion may be regarded as being twice the linear expansion. In precisely the same way the cubic expansion is practically three times the linear.

To find the expansion of a liquid, the cubic expansion of the vessel which contains that liquid must be known. If a flask with a perforated cork taking a long tube be filled with water up to a point somewhere in the tube, and heat is applied, the level of the water first of all falls on account of the expansion of the flask. The difference between the original level of the water and the level to which it sinks must be equal to the cubic expansion of the material of which the flask is made. If the application of heat be continued, the level of the water will rise above the original mark.

If
A = the original level,
B = reduced level,
C = raised or final level,

then
A – B = cubic expansion of the vessel,
C – A = apparent expansion of the water,
C – B = real expansion of the water.

∴ the real expansion of a liquid is its apparent expansion + the cubic expansion of the vessel.

Barometers. A barometer is an instrument for measuring the

weight or pressure of the atmosphere. On an average the air exerts a pressure of about 14·7 lbs. per square inch of the earth's surface. If our atmosphere could be supplanted by a sea of mercury 760 mm. in depth, the same pressure would be exerted. It is for this reason that we say, under normal conditions, the pressure of the atmosphere is equal to 760 mm. or 29·9 inches of mercury. To construct a barometer a glass tube 33 inches long is filled with boiled mercury (to expel all air). The tube is then closed with the thumb, inverted, and the lower end plunged into a cistern containing more mercury. When the thumb is removed some of the mercury will fall into the cistern, but the column which remains suspended in the tube will represent the pressure of the air at the time. The vacant space left at the top of the tube is known as the Torricellian vacuum. If the air increases in pressure, the level of the mercury in the cistern is compressed, and consequently the mercury in the tube ascends. The column therefore has been extended, not only by the amount the mercury has ascended in the tube, but also by that degree of fall which has occurred in the cistern. With Fortin's standard barometer (Fig. 16), the one usually employed, to compensate for this "error of capacity" and in order to standardise all readings, the leather base of the cistern can be raised or lowered by means of a screw *a* until the level of the mercury just touches the tip of an ivory point *b* called the fiducial point, which forms the zero of the scale; consequently this adjustment allows an accurate reading to be made.

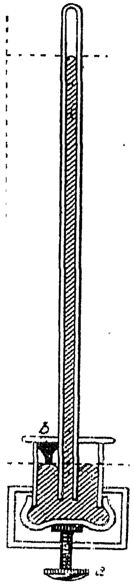


FIG. 16.

The barometer scale is marked off in inches, each inch being sub-divided into twenty equal divisions. The instrument is read to the nearest division below the level of the mercury in the tube. The vernier is then so adjusted that its base is tangential with the top of the convexity of the mercury. Note the point at which a division on the vernier exactly corresponds with one on the main scale. Count from below upwards how many of the twenty-five vernier divisions have to be passed before this point is reached. Multiply this number by 0·002 and add the product to the first reading on the main scale. The answer gives the pressure of the air in terms of inches of mercury. The main scale is also divided into centimetres and millimetres. The vernier is not required when the metric system is employed.

The 0·002 is a constant, and is obtained as follows:—

Twenty-five vernier divisions equal in total length twenty-four scale divisions. As 1 scale division = 0·05 of an inch, 24 = 24 × 0·05 = 1·2 inches.

$\therefore$ 25 vernier divisions = 1·2 inches.

$\therefore$ 1 vernier division = $\frac{1}{25}$ of 1·2 inches = 0·048 of an inch.

$\therefore$ 1 scale division − 1 vernier division = 0·05 − 0·048 = 0·002.

It is more accurate to measure pressure in millibars than in inches or millimetres. The "bar" = 1,000 millibars = 750 millimetres = 29·53 inches = 1,000,000 dynes per square centimetre.

A dyne is the unit of force and is that force which will accelerate the velocity of 1 gramme 1 centimetre per second. At sea level the acceleration due to gravity upon any falling body is 32 feet or 981 centimetres per second; hence the force of gravity upon a mass of 1 gramme is 981 dynes.

In order to get an accurate barometric reading, corrections have to be made for the following errors :—

(1) Temperature ; (2) altitude ; (3) capillarity ; (4) index ; (5) capacity.

1. An allowance must be made for the expansion or contraction of the mercury due to differences of temperature. The brass scale is also similarly affected. Corrections are made by formulæ.

2. The pressure varies with the altitude. It is near enough for most practical purposes to allow a fall of 1 inch for every 1,000 feet of ascent. It is on this principle that heights are estimated by barometric readings.

3 and 4. These vary with each instrument, and are supplied with all certificated instruments.

5. The correction for this error has been described.

The Meteorological Office, on being furnished with a copy of the National Physical Laboratory certificate for a barometer, also with the height and latitude of the station at which the barometer is to be used, will supply barometric correction cards, by the use of which due allowance is made for all errors and corrections with one entry ; thus a saving of considerable labour is effected.

In the **Kew barometer** the base of the cistern is fixed and there is no fiducial point. The error of capacity is obviated by making the " inches " on the scale shorter by 0·04 of an inch. The relationship between the size of the tube and that of the cistern is such that a rise of 0·96 of an inch of the mercury in the tube is accompanied by a fall of 0·04 of an inch of the mercury in the cistern. The column therefore is really longer by 1 inch.

Mercury is used for barometer construction because of the advantages it possesses in not wetting the tube and in the shortness of the column in consequence of its high specific gravity. If water were used a tube about 36 feet long would have to be employed. This would allow smaller variations of atmospheric pressure to be more easily observed ; but as water freezes at a comparatively high temperature and has a high vapour pressure it is practically useless. Glycerine might be selected as it does not freeze at any terrestrial temperature. As the specific gravity of glycerine is only about one-tenth that of mercury, it is obvious that it would magnify ten times the reading of a mercurial barometer. Its drawback is its hygroscopic property, but this can be removed by covering that portion which is in the cistern with paraffin oil.

The **aneroid barometer**, as the name implies, contains no fluid. It consists of a small hermetically sealed German-silver box exhausted of air. Owing to the elasticity of the metal, the sides tend to collapse with an increase of atmospheric pressure. A spring, however, is so attached that it acts in opposition. With any variation of pressure therefore the spring is either compressed or relaxed. The movements of the spring are translated by a pointer on a dial. The **barograph** is a self-recording instrument and is simply an aneroid barometer. The movements of the vacuum chamber, which in this case is made of concentric rings to increase elasticity, are recorded by means of a pen on a revolving drum, on precisely the same principle as the self-registering thermometer.

Siphons. The explanation of the action of a siphon is one of atmospheric pressure. If the level of the liquid in the longer leg of the siphon corresponds with the level of the liquid in the vessel, the liquid is in a state of equilibrium, that is, the air pressure on each side has precisely the same volume of liquid to support ; consequently the liquid remains stationary. If the longer leg is filled, then the addi-

tional volume of liquid which it contains flows out in order to re-establish the balance; other portions of the fluid now flow on to occupy the same position, and so the process is continued.

Formulæ for Calculating Superficial and Cubic Space

Superficial space

Area of rectangle and square. The length multiplied by the breadth.

Area of rhombus or rhomboid (in which the opposite sides are parallel). The base multiplied by the perpendicular height.

Area of trapezoid. Half the sum of the two parallel sides multiplied by the width.

Area of triangle. Half the product of base and height.

Area of regular polygon. The sum of the sides (perimeter) multiplied by half the perpendicular (drawn from the centre to the middle point of any side).

Area of parabola. The base multiplied by two-thirds of the height.

Area of circle. Square of diameter multiplied by 0·7854 or square of radius multiplied by 3·1416.

Area of ellipse. The product of the long and short diameters multiplied by 0·7854.

Area of segment of a circle. The cube of the height divided by twice the length of the chord added to two-thirds of the product of chord and height. *Note:* When the segment is greater than a semicircle, find the area of the circle and deduct the area of the smaller segment.

Area of sector of a circle. Half the product of the arc multiplied by the radius.

Area of sphere. Diameter squared, multiplied by 3·1416, or four times square of radius multiplied by 3·1416.

Cubic space

Volume of cube or rectangular room. The length multiplied by the breadth multiplied by the height.

Volume of prism. Area of base multiplied by height.

Volume of cylinder. Area of base multiplied by height.

Volume of cone or pyramid. The area of base multiplied by one-third of the perpendicular height.

Volume of dome (segment of a sphere). Area of base multiplied by two-thirds of the height.

Volume of sphere. Cube of diameter multiplied by ·5236, or four-thirds square of radius multiplied by 3·1416.

Volume of wedge. Area of base multiplied by half of the perpendicular height.

Volume of frustum of cone or pyramid. The sum of the areas of the two ends of the frustum and the square root of their product, multiplied by one-third of the height of the frustum.

The cubic capacity of a marquee used as a hospital ward may be found by dividing it into (*a*) body—a solid rectangle with a half cylinder at each end; (*b*) roof—a solid triangle and two half cones.

Heat and thermo-chemistry

The centimetre-gramme-second system (C.G.S.) unit of heat is the calorie, which is the quantity of heat required to raise 1 gram of water through 1° C.

The large or major Calorie (sometimes spelt with a "K") is the quantity of heat required to raise 1 kilogram of water through 1° C.

in the neighbourhood of 15° C. This is the metric unit of heat adopted for technical purposes, and is known as the K.C.U.

The British Thermal Unit (B.Th.U.) is the amount of heat required to raise 1 lb. of water through 1° F. in the neighbourhood of 60° F.

Tables, Factors for Conversion and Formulæ

Comparative Table of Thermometer Scales Centigrade and Fahrenheit

C.	F.	C.	F.	C.	F.	C.	F.
−10	14·0	20	68·0	50	122·0	80	176·0
−9	15·8	21	69·8	51	123·8	81	177·8
−8	17·6	22	71·6	52	125·6	82	179·6
−7	19·4	23	73·4	53	127·4	83	181·4
−6	21·2	24	75·2	54	129·2	84	183·2
−5	23·0	25	77·0	55	131·0	85	185·0
−4	24·8	26	78·8	56	132·8	86	186·8
−3	26·6	27	80·6	57	134·6	87	188·6
−2	28·4	28	82·4	58	136·4	88	190·4
−1	30·2	29	84·2	59	138·2	89	192·2
0	32·0	30	86·0	60	140·0	90	194·0
1	33·8	31	87·8	61	141·8	91	195·8
2	35·6	32	89·6	62	143·6	92	197·6
3	37·4	33	91·4	63	145·4	93	199·4
4	39·2	34	93·2	64	147·2	94	201·2
5	41·0	35	95·0	65	149·0	95	203·0
6	42·8	36	96·6	66	150·8	96	204·8
7	44·6	37	98·6	67	152·6	97	206·6
8	46·4	38	100·4	68	154·4	98	208·4
9	48·2	39	102·2	69	156·2	99	210·2
10	50·0	40	104·0	70	158·0	100	212·0
11	51·8	41	105·8	71	159·8	101	213·8
12	53·6	42	107·6	72	161·6	102	215·6
13	55·4	43	109·4	73	163·4	103	217·4
14	57·2	44	111·2	74	165·2	104	219·2
15	59·0	45	113·0	75	167·0	105	221·0
16	60·8	46	114·8	76	168·8	106	222·8
17	62·6	47	116·6	77	170·6	107	224·6
18	64·4	48	118·4	78	172·4	108	226·4
19	66·2	49	120·2	79	174·2	109	228·2
—	—	—	—	—	—	110	230·0

Remarks.

The Réaumur scale (not much used) is from 0° (Freezing Point) to 80° (Boiling Point).

To convert Centigrade to Fahrenheit:—

$$F = \frac{9C}{5} + 32.$$

To convert Fahrenheit to Centigrade:—

$$C = \frac{5(F - 32)}{9}$$

To convert Centigrade to Réaumur:—

$$R = \frac{4C}{5}.$$

To convert Réaumur to Centigrade:—

$$C = \frac{5R}{4}.$$

To convert Fahrenheit to Réaumur:—

$$R = \frac{4(F - 32)}{9}.$$

To convert Réaumur to Fahrenheit:—

$$F = \frac{9R}{4} + 32.$$

Note. $F = C + R + 32.$

Weights and Measures

Metric system

Weights

The gramme (the weight of 1 cubic centimetre of water at 4° C.) is the unit.

10 milligrammes	1 centigramme.
10 centigrammes	1 decigramme.
10 decigrammes	1 gramme.
10 grammes .	1 decagramme.
10 decagrammes	1 hectogramme.
10 hectogrammes	1 kilogramme.
10 kilogrammes	1 myriagramme.
10 myriagrammes	1 quintal.
10 quintals .	1 millèr or bar.

Measures of length

The metre (approximately one ten-millionth part of the distance from one of the earth's poles to the equator at the meridian of Paris) is the measure of length.

Measures of length.

10 millimetres	1 centimetre.
10 centimetres	1 decimetre.
10 decimetres	1 metre.
10 metres	1 decametre.
10 decametres	1 hectometre.
10 hectometres	1 kilometre.
10 kilometres	1 myriametre.

Measures of capacity

The litre (the volume of a kilogramme of pure water at its temperature of maximum density, 4° C., and under an atmospheric pressure of 760 millimetres of mercury) is the unit.

10 millilitres	1 centilitre.
10 centilitres	1 decilitre.
10 decilitres	1 litre or cubic decimetre.
10 litres	1 decalitre.
10 decalitres	1 hectolitre.
10 hectolitres	1 kilolitre or cubic metre.
10 kilolitres	1 myrialitre.

British

Avoirdupois weight

16 drachms	1 ounce.
16 ounces	1 pound.
14 pounds	1 stone.
28 pounds	1 quarter.
4 quarters o[illegible] pounds	1 cwt.
20 cwts.	1 ton.

Dry measure

2 pints	1 quart.
2 quarts	1 pottle.
4 quarts	1 gallon.
2 gallons	1 peck.
4 pecks	1 bushel.
2 bushels	1 strike.
4 bushels	1 coomb.
8 bushels	1 quarter.
5 quarters	1 load.
10 quarters	1 last.

asures of length

12 inches	1 foot.
3 feet	1 yard.
2 yards	1 fathom.
5½ yards	1 pole.
22 yards	1 run.
220 yards	1 furlong.
8 furlongs 1,760 yards 5,280 feet	1 statute mile

Measures of length

6,082·66 feet	1 nautical mile or knot.
7·92 inches	1 link.
100 links	1 chain.
66 feet	1 chain.
22 yards	1 chain.

Square measure

144 square inches . . .	1 square foot.
9 square feet	1 square yard.
272¼ square feet . . .	1 square rod or pole.
30¼ square yards . . .	1 square rod or pole.
40 square rods	1 square rood.
4 square roods	1 acre.
160 square rods . . .	1 acre.
4,840 square yards . . .	1 acre.
10 square chains . . .	1 acre.
640 acres	1 square mile.
30 acres	1 yard of land.
100 acres	1 hide of land.
40 hides	1 barony.

Cubic measure

1,728 cubic inches	1 cubic foot.
27 cubic feet .	1 cubic yard.

Angular measure

60 seconds (″)	1 minute.
60 minutes (′)	1 degree.
90 degrees	1 quadrant.
360 degrees	1 circle.

Miscellaneous

1 stone . .	14 pounds.
1 score . . .	20 pounds
1 gross . . .	12 dozen.
1 quire . . .	24 sheets.
1 ream . . .	20 quires.
1 cord of wood . .	128 cubic feet.
1 ton of coal . .	10 sacks.
1 ton of Portland cement	10 sacks or 6 casks.
1 barrel of tar . .	25 gallons.
1 ton	2,240 pounds.
1 pound (avoirdupois) .	7,000 grains.
1 ounce (avoirdupois) .	437·5 grains.
1 gallon . . .	70,000 grains.
1 teaspoon (fluid) . .	5 c.c. or ⅙th fluid ounce.
1 dessertspoon (fluid) .	10 c.c. or ⅓rd fluid ounce.
1 table spoon (fluid) .	15 c.c. or ½ fluid ounce.
1 cup or tumbler (fluid).	250 c.c. or 8 fluid ounces.

British and metric equivalents

1 millimetre . .	0·03937 inch.
1 metre . . .	39·37079 inches.
1 decimetre . . .	3·94 inches.
1 cubic metre . .	35·31628 cubic feet.
1 square metre . .	10·7642 square feet.
1 centimetre .	0·3937 inches.

British and metric equivalents

1 cubic centimetre	0·06103 cubic inch.
1 kilometre	1,093·6331 yards.
1 litre of water	61·02705 cubic inches. 35·27 ounces (avoirdupois) 1·76 pints. 0·22 gallon.
1 milligramme	0·01543 grain.
1 gramme	15·43235 grains.
1 kilogramme	2·2 pounds (avoirdupois).
1 ton	1,015·649 kilogrammes.
1 pound (avoirdupois)	453·415 grammes.
1 ounce (avoirdupois)	28·35 grammes.
1 ounce (fluid)	28·4 cubic centimetres.
1 inch	2·54 centimetres.
1 foot	3·05 decimetres.
1 yard	0·91 metre.
1 mile	1·61 kilometres.
1 pint	0·57 litre.
1 gallon	4·54 litres.

Useful factors for conversion

To convert—	Multiply by—
Inches to metres	0·02540
Metres to inches	39·37
Metres to yards	1·09
Feet to miles	0·00019
Yards to miles	0·00057
Yards to centimetres	91·44
Inches to centimetres	2·539
Millimetres to inches	0·03937
Inches to millimetres	25·399
Centimetres to inches	0·3937
Metres to feet	3·28
Feet to metres	0·3047
Kilometres to miles	0·6
Grammes to pounds (avoirdupois)	0·0022
Pounds to grammes	453·715
Kilogrammes to pounds	2·204
Kilogrammes to stones	6·35
Tons to kilogrammes	1,018·2
Kilogrammes to ounces	35·3
Kilogrammes to tons	0·00098
Pounds to kilogrammes	9·4537
Grammes to grains	15·432
Grains to grammes	0·0648
Ounces to grammes	28·35
Grammes to ounces (avoirdupois)	0·0353
Litres to gallons	0·22
Gallons to litres	4·537
Litres to pints	1·76
Pints to litres	0·568
Litres to fluid ounces	35·2
Cubic centimetres to fluid ounces	0·0352
Cubic metres to gallons	220·4
Cubic metres to pints	1,763·2
Cubic metres to fluid ounces	35,264·0
Fluid ounces to cubic centimetres	28·57

Useful factors for conversion

To convert—	Multiply by—
Cubic feet to gallons . . .	6·25
Gallons to cubic feet . . .	0·1605
Cubic inches to gallons . . .	0·003607
Cubic inches to pints . . .	0·0288
Pints to cubic inches . . .	34·6592
Cubic inches to fluid ounces . .	0·577
Fluid ounces to cubic inches . .	1·7299
Cubic inches to cubic centimetres .	16·386
Cubic centimetres to cubic inches .	0·061
Cubic feet to cubic metres . .	0·0283
Cubic metres to cubic feet . .	35·32
Cubic metres to gallons . . .	220·4
Cubic feet to litres	28·31
Litres to cubic feet	0·0354
Litres to cubic inches . . .	61·027
Pints to cubic centimetres . .	568·182
Square feet to square metres . .	0·0929
Square metres to square feet . .	10·764
Hectares to acres	2·47
Square feet to square yards . .	0·111
Parts per 100,000 into grains per gallon	0·7
Grains per gallon to parts per 100,000	1·43

APPENDIX III

ANTHROPOMETRIC MEASUREMENTS

Record the following details for each subject :—

Name : Place :
Nationality :
Occupation :
Age : Date of birth :

(Give age in years and months—the latter a fraction of 12, *e.g.* 9, 6/12 = 9 years 6 months.)

Height :
Sitting Height :
Weight :
Chest Measurement
Notes :

Height. Measured according to the following method :—

Select a door or wooden wall. Take the tape measure provided, and with the zero end touching the floor pin the tape to the bottom of the door by means of a drawing-pin. Stand the child in stockinged feet with the heels together and touching the wall immediately under the tape measure. The buttocks, shoulder blades and occiput should then be allowed to touch the door. The head should be balanced evenly on the shoulders so that the eyes look straight forward. Then take the right-angle piece provided, and place it on the tape so that the shorter edge lies flat against the vertical tape and pointing upwards. The longer edge will then project outwards horizontally. By means of the fingers run the right-angle piece up and down the surface of the tape until the lower surface of the longer edge just touches the scalp of the child. This only requires a light but firm pressure, just sufficient to compress the hair on the crown of the head. The hair should not be bunched up on the crown by means of a hair ribbon or similar appliance.

The reading of the tape at the point where it is obscured by the angle of the right-angle piece is then carefully noted. Thus the correct height of the child is obtained. The child and the right-angle piece should then be moved slightly away from the tape and then replaced for another reading. The same procedure should be carried out for a third time.

Three readings are thus obtained. Record each reading before proceeding to the next reading. Enter the height in inches, not in feet and inches.

Sitting height. Sit the child on the floor against the door so that the sacrum, shoulder blades and occiput touch the door, and the legs stretch out along the floor at right angles to the door. Take the readings in the same way as described for stature.

Weight. The question of the suitability of the weighing machine which it is proposed to use is of fundamental importance. As weighing machines vary so much in type and efficiency, it is felt impracticable to lay down rules for each type. The selection of the machine to be used is therefore left to the discretion of the examiner.

It is suggested that he should consult the inspector of weights and measures employed by his authority. The inspector will probably be ready to test the machine for general efficiency and to check the register against a known accurate register, so that a factor of error (if any) can be ascertained. This factor should then be applied to all weights taken. The machine should be re-tested periodically.

Two records of weight are asked for in order that the second record may be used as a check on the accuracy of the first. If any serious discrepancy is found, then a third record should be taken, and of the three records the two which are the most similar should be the ones selected.

It is sufficient to take the weight to the nearest 4 ounces.

The amount of clothing worn by the child will obviously have a

MEAN HEIGHTS AND WEIGHTS OF 24,000 ENGLISH ELEMENTARY SCHOOL CHILDREN, 1927

(From Annual Report of Chief Medical Officer of the Board of Education for the Year 1927.)

Age.	Height (inches).		Weight (pounds).	
	Boys.	Girls.	Boys.	Girls.
3 .	36·9	36·6	32·9	31·5
4 .	39·2	38·4	35·9	33·7
5 .	41·4	41·1	38·7	37·5
6 .	43·0	42·8	41·3	40·1
7 .	45·4	45·1	45·4	44·4
8 .	47·8	47·5	51·0	49·4
9 .	49·2	48·9	54·8	52·6
10 .	51·3	51·2	59·6	59·8
11 .	52·7	52·8	64·6	63·9
12 .	55·0	55·6	71·6	73·9
13 .	56·2	56·9	76·5	79·0
14 .	58·0	58·9	86·1	88·2
15 .	61·8	62·5	99·3	106·8
16 .	66·0	62·2	118·0	106·5
17 .	66·4	63·4	122·6	112·3
18 .	68·5	63·3	128·8	118·4

marked influence on the accuracy of the measurement. The child should be wearing as little as is practicable, but not less than :—

Boys—trousers and stockings.

Girls—knickers or drawers, together with chemise or vest or combinations, and stockings.

A series of factors for this amount of clothing can be calculated and applied to each recorded weight.

If, however, on grounds of expediency or for any other reason the investigator permits the child to wear any garments additional to the above, he should enter the name of the additional garment in the space allocated for the purpose. In no case, however, should the child be weighed while wearing boots or jacket or frocks or similar heavy articles with wide variations in weight.

Chest measurement. The measurement should be taken by means of the tape provided. The procedure is as follows :—

The chest having been completely laid bare to the waist, both back and front, the child is made to stand at "attention." With the examiner facing the child, the tape is then passed round the chest so that the tape passes over the lower angle of each scapula and across the 4th intercostal space in front. This space will correspond to the nipples in boys, but may not in girls.

The tension of the tape should be firm, but not so firm as to pucker the skin.

The child is then asked to hold the arms straight up over the head and to count twenty aloud quickly—all in the same breath. The measurement should be taken at the end of this period of expiration.

Three such measurements should be taken.

Note. Record any abnormality or disease likely to influence the findings *e.g.* defects, deformities or diseases which have been noted or mentioned by subject or parents.

Notes. "There are a number of factors, racial, developmental, social and hygienic, which play an important part in determining the growth of the child, and these factors cannot be disregarded when comparing the figures for one locality with those of another. Nevertheless, the norms for height and weight will at once be of value to School Medical Officers, School Nurses and Teachers in roughly estimating, for instance, the difference in weight between the normal healthy child and an individual child who appears to be undernourished."

APPENDIX IV

RESOLUTIONS AND RULES OF THE GENERAL MEDICAL COUNCIL

PUBLIC HEALTH

FOR DIPLOMAS AND DEGREES IN SANITARY SCIENCE PUBLIC HEALTH, OR STATE MEDICINE

ADOPTED BY THE GENERAL MEDICAL COUNCIL ON MAY 28, 1937

The Council, having regard to the special privileges accorded by statute to the holders of Diplomas or Degrees in Sanitary Science, Public Health, or State Medicine, granted under section 21 of the Medical Act, 1886, will not consider such Diplomas or Degrees to "deserve recognition in the Medical Register" unless they have been granted under such conditions of education and examination as shall ensure, in the judgment of the Council, the possession of a distinctively high proficiency, scientific and practical, in all branches of study which concern the Public Health. In forming their judgment on such conditions of education and examination, the Council will expect the following Rules to have been observed.

RULES

1. A period of not less than two years shall elapse between the attainment by a candidate of a qualification in Medicine, Surgery and Midwifery and the grant of a Diploma or Degree in Sanitary Science, Public Health or State Medicine.

2. The curriculum for a Diploma or Degree in Sanitary Science, Public Health or State Medicine shall extend over a period of not less than (*a*) twelve calendar months of which not less than three consecutive calendar months shall be devoted to the whole-time study of the subjects comprised in Rule 3, *or* (*b*) an academic year of whole-time study covering a period of not less than nine calendar months, subsequent to the attainment of a medical qualification.

3. Every candidate shall produce evidence of satisfactory and regular attendance on a course lasting not less than 280 hours, at an institution approved by the Licensing Body granting the Diploma or Degree, during which he shall have received :—

(*a*) Theoretical and practical instruction in Bacteriology and Parasitology (including immunology, serology, and medical entomology), in relation to the public health ;

(*b*) Instruction in the application of the principles of Physiology and Biochemistry to environmental and personal hygiene and to the public health ;

(*c*) Instruction in the application of the principles of Chemistry and Physics to environmental and personal hygiene and to the public health, including the methods of examination and purification of water and sewage, the composition and

various forms of adulteration of the more common foods, the nature (and methods of estimation) of pollution of the atmosphere, and methods of disinfection and disinfestation.

4. Every candidate shall produce evidence of satisfactory and regular attendance on a course lasting not less than 160 hours, at an institution approved by the Licensing Body granting the Diploma or Degree, during which he shall have received instruction in the following subjects :—

(*a*) The Principles of Hygiene, Sanitation, and Public Health ;
(*b*) Epidemiology and Vital Statistics (including statistical method) ;
(*c*) Public Health Law and Administration (including social insurance, public medical services, and hospital administration) ;
(*d*) Industrial Hygiene and the welfare of industrial workers ;
(*e*) House Planning and Sanitary Construction ;
(*f*) The Principles of Genetics ;
(*g*) Mental Hygiene.

5. Every candidate shall produce evidence that he has attended satisfactorily and regularly for three months on the clinical practice of a Hospital for Infectious Diseases approved by the Licensing Body granting the Diploma or Degree.

6. Every candidate shall produce evidence that he has, during a period of not less than six months, been engaged in acquiring a practical knowledge of the duties, routine and special, of Public Health Administration under the supervision of a Medical Officer of Health, who shall certify that the candidate has received, from this Officer or other competent Officer, during not less than three hours on each of sixty working days, practical instruction in these duties, including those of :—

(*a*) Maternity and Infant Welfare Service ;
(*b*) Health Services for Young Children and Children of School Age ;
(*c*) Venereal Diseases Service
(*d*) Tuberculosis Service ;
(*e*) Industrial Hygiene ;
(*f*) Hospital Services ;
(*g*) Mental Health Services ;
(*h*) Inspection and Control of Food, including meat and milk.

Note. Instruction in the matters specified under the foregoing heads (*a*) to (*h*) should include attendance at the centres, clinics, institutions, and premises concerned.

Certificates of having received the prescribed instruction in Public Health Administration must be given by a Medical Officer of Health who devotes his whole time to Public Health work of an area approved by the Licensing Body granting the Diploma or Degree.

7. The examination for the Diploma or Degree shall be divided into two parts, Part I and Part II, each of which shall extend over not less than two days, and shall be conducted by Examiners specially qualified.

A candidate must pass Part I before being admitted to examination for Part II, and in both Parts a candidate must pass in all the specified subjects at one time.

8. The examination for Part I shall include written and oral examinations in the subjects comprised in Rule 3, together with a practical laboratory examination in the subjects specified in Rule 3 (*a*).

Candidates shall not be admitted to examination for Part I until

after they have completed the prescribed courses of instruction in the subjects thereof.

9. The examination for Part II shall include the subjects referred to in Rules 4, 5 and 6.

The examination shall be written and oral, and shall include clinical examinations in Infectious Diseases, and practical examinations in Food Inspection and Inspection of Premises, including dwellings, factories, workshops and schools.

Candidates shall not be admitted to examination for Part II until after they have completed the prescribed courses of instruction in the subjects thereof.

Note. The observance of these Rules does not prevent any Licensing Body granting the Degree or Diploma, or any institution approved by such Body, from requiring a larger number of hours than those specified to be spent in the study of prescribed subjects, or requiring instruction to have been given in subjects additional to those prescribed. Indeed, the use in Rules 8 and 9 of the word "include" implies that knowledge of other subjects may be tested as part of the examination. The duties of Local Authorities and their Medical Officers are constantly being extended by legislation, and modern scientific research is making available in new directions knowledge of the greatest importance to Medical Officers of Health and to other Medical Officers engaged in public health work.

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